ALBERT R. MANN
LIBRARY
AT
CORNELL UNIVERSITY

DATE DUE

~~MAR 9 1979~~			
~~MAY [illegible] 1999~~			
GAYLORD			PRINTED IN U.S.A.

CORNELL UNIVERSITY LIBRARY

3 1924 055 253 805

MYCOTAXON

VOLUME III, 1975-1976

COMPLETE IN THREE QUARTERLY ISSUES
CONSISTING OF v + 580 PAGES
INCLUDING FIGURES

CO-EDITORS

G. L. HENNEBERT
French Language Editor & Book Review Editor

RICHARD P. KORF
English Language Editor & Managing Editor

QK
600
M992
V. 3
1975/76

Published by
MYCOTAXON, LTD., P.O. BOX 264, ITHACA, NY 14850, USA
Printed in the United States of America

ERRATA TO VOLUME THREE

age 30, line 15:	*for:*	*Hyalospora*
	read:	*Hyalopsora*
age 64, line 3:	*for:*	**Sporomiella*
	read:	**Sporormiella*
age 154, line 33:	*for:*	*Agrotelium*
	read:	*Argotelium*
age 191, line 28:	*for:*	*languinea*
	read:	*sanguinea*
age 216, line 2:	*for:*	CE
	read:	C-E
age 282, line 33	*for:*	Grave
	read:	Grove
age 286, line 4:	*for:*	10-16
	read:	7-9
age 287, line 6:	*for:*	10 µ, paries 2,6 µ)
	read:	20 µ, paries 7 µ)
age 295, line 26:	*for:*	2,6 µ)
	read:	7 µ)
age 296, line 7:	*for:*	höheren
	read:	Höheren
age 298, line 37:	*for:*	Alexopoulos (1968)
	read:	Alexopoulos and Blackwell (1968)
age 317, line 2:	*for:*	Alexopoulos, C. J. 1968.
	read:	Alexopoulos, C. J. and M. Blackwell. 1968.
age 319, line 25:	*for:*	(Obrien
	read:	(O'Brien

ERRATA (Vol. 3): p.303, 1.22, *for* IPN 54 *read* Garcia 54 ENCB; 1.24, *for* IPN 6801 *read* Guzmán 6801 ENCB; 1.27, *for* IPN 262 *read* Mendiola 262 ENCB; 1.31, *for* IPN 1513 *read* Ventura 1513 ENCB; 1.35, *for* IPN 7967 *read* Guzmán 7967 ENCB; p.305, 1.11, *for* IPN 6585 *read* Guzmán 6585 ENCB; 1.14, *for* IPN 6230 *read* Guzmán 6230 ENCB; p.306, 1.33, *for* IPN 8052 *read* Guzmán 8052 ENCB; p.309, 1.24, *for* IPN 12 *read* Huerta 12 ENCB; p.310, 1.6, *for* IPN 10051 *read* Guzmán 10051 ENCB; 1.24, *for* IPN 89 *read* Romero 89 ENCB; 1.32, *for* IPN 13 *read* Araiza 13 ENCB; p.313, 1.35, *for* IPN 93 *read* Romero 93 ENCB; p.315, 1.25, *for* IPN 68-A *read* Uribe 68-A ENCB; p.316, 1.20, *for* IPN 198 *read* Mendiola 198 ENCB.

TABLE OF CONTENTS, VOLUME THREE

AMES, ROBERT N. AND ROBERT G. LINDERMAN
Acaulospora trappei sp. nov. 565

AMMIRATI, JOSEPH F.
Cortinarius, section *Dermocybe* — *Cortinarius clelandii* 95

BARR, MARGARET E.
The genus *Ostreichnion* 81

Hypoxylon grandineum: a loculoascomycete 325

BERTOLDI, M. DE
Puciola spinosa, a new dematiaceous hyphomycete from soil 553

see MOORHOUSE & DE BERTOLDI

BIGELOW, HOWARD E., ORSON K. MILLER, JR., & HARRY D. THIERS
A new species of *Omphalotus* 363

BRAUN, KARL LEO & HAROLD W. KELLER
Myxomycetes of Mexico I 297

BURDSALL, H. H., JR., *see* GILBERTSON *et al.*

BURK, WILLIAM R.
Pseudocolus javanicus in Connecticut and its distribution in the United States 373

CAIN, R. F., *see* JENG & CAIN

CANFIELD, E. R., *see* GILBERTSON *et al.*

CARPENTER, STEVEN E.
Taxonomy, morphology and ontogeny of *Gelatinodiscus flavidus* .. 209

CONSTANTINESCU, O.
Revision of *Cercospora* species (Hyphomycetes) parasitic on *Psoralea* 119

DEMOULIN, V.
Species of *Lycoperdon* with a setose exoperidium 275

GILBERTSON, R. L., H. H. BURDSALL, JR., & E. R. CANFIELD
Fungi that decay mesquite in southern Arizona 487

HALE, MASON E., JR.
Studies on the lichen family Thelotremataceae. 3. 173

Synopsis of a new lichen genus, *Everniastrum* Hale (Parmeliaceae) 345

HENNEBERT, G. L.
Book Reviews 182, 318, 354

HOMOLA, RICHARD L.
A new species of *Lactarius* section *Plinthogali* from northeastern North America 331

HORN, CORINNE, *see* REEVES & HORN

HUANG, L. H. & J. A. SCHMITT
Soil microfungi of central and southern Ohio 55

JENG, R. S. & R. F. CAIN
A new species of *Eoterfezia* from Mexico and Venezuela 387
A new species of *Ascodesmis* from Venezuela 391

JONG, S. C., *see* KING & JONG, *see* ROXON & JONG

JONG, S. C. & E. E. DAVIS
Phialocephala gabalongii as a synonym of *Phialocephala humicola* 126
Contribution to the knowledge of *Stachybotrys* and *Memnoniella* in culture 409

JONG, S. C. & D. S. KING
A nomenclatural note concerning *Sarcinomyces* Lindner and *Sarcinomyces* Oho 397

KARR, G. W., JR., *see* MORGAN-JONES AND KARR

KELLER, HAROLD W., *see* BRAUN & KELLER

KING, D. S., *see* JONG & KING

KING, D. S. & S. C. JONG
Sarcinosporon: a new genus to accommodate *Trichosporon inkin* and *Prototheca filamenta* 89
Aciculoconidium: a new hyphomycetous genus to accommodate *Trichosporon aculeatum* 401

KOHN, LINDA M. & RICHARD P. KORF
Variation in Ascomycete iodine reactions: KOH pretreatment explored 165

KORF, RICHARD P., *see* KOHN & KORF, *see* SHERWOOD & KORF

KRAMER, CHARLES L., *see* REDDY & KRAMER

LAUNDON, G. F.
Taxonomy and nomenclature notes on Uredinales 133

LINDERMAN, ROBERT G., *see* AMES & LINDERMAN

MAJEWSKI, TOMASZ, *see* TAVARES & MAJEWSKI

MILLER, ORSON K., JR., *see* BIGELOW *et al.*

MISRA, P. C.
A new species of *Syncephalastrum* 51

MOORHOUSE, J. & M. DE BERTOLDI
Electrophoretic characteristics of enzymes as a taxonomic criterion in the genus *Humicola* 109

MORGAN-JONES, G.
Notes on Hyphomycetes. VIII. *Lylea,* a new genus 129

MORGAN-JONES, G. AND G. W. KARR, JR.
Notes on Hyphomycetes. IX. A new species of *Curvularia* 559

PETERSEN, RONALD H.
Specific and infraspecific names for fungi used in 1821. Part III. D–G. 239
Cultural characteristics of *Auriscalpium* and *Gloiodon* 358

PFISTER, DONALD H.
Scanning electron micrographs of ascospores of *Pachyella* (Discomycetes) 105

Comments on the Scleromyceti Sueciae in the Farlow Herbarium .. 185

REDDY, M. SUGUNAKAR & CHARLES L. KRAMER
A taxonomic revision of the Protomycetales 1

REEVES, F. BRENT & CORINNE HORN
Trichoderma in Colorado 337

ROXON, J. E. & S. C. JONG
Arthrobotrys entomopaga in pure culture 162

SCHMITT, J. A., *see* HUANG & SCHMITT

SHERWOOD, MARTHA A.
The genus *Platysticta* 233

SHERWOOD, MARTHA A. & RICHARD P. KORF
A revision of *Helotiopsis* 319

SUNDBERG, WALTER J.
Lepiota sensu lato in California. II. Type studies of *Lepiota cupressea* and *Lepiota marginata* 381

SUTTON, B. C.
Angiopoma Lév., 1841, an earlier name for *Drechslera* Ito, 1930 377

TAVARES, ISABELLE I. & TOMASZ MAJEWSKI
Siemaszkoa and *Botryandromyces*, two segregates of *Misgomyces* (Laboulbeniales) 193

THIERS, HARRY D.
Boletes of the southwestern United States 261

see BIGELOW *et al.*

THOMSON, JOHN W., *see* WEBER & THOMSON

VEZDA, ANTONIN & WILLIAM A. WEBER
A new species of *Polychidium* (Lichenes: Peltigeraceae) from New Guinea 355

WEBER, WILLIAM A., *see* VEZDA & WEBER

WEBER, WILLIAM A. & JOHN W. THOMSON
Physcia duplicorticata Weber & Thomson sp. nov. from California 102

Errata 580

Index to Fungous and Lichen Taxa 570

Notices

MYCOTAXON policy on arguments supporting proposals on nomina generica conservanda 274

Second International Mycological Congress 1977 330

Reviewers 579

LIBRARY
ITHACA, N. Y. 14850
NOV 11 1975

MYCOTAXON

AN INTERNATIONAL JOURNAL DESIGNED TO EXPEDITE PUBLICATION OF RESEARCH ON TAXONOMY & NOMENCLATURE OF FUNGI & LICHENS

Vol. III October-December 1975 No. 1

CONTENTS

A taxonomic revision of the Protomycetales.
M. SUGUNAKAR REDDY AND CHARLES L. KRAMER 1
A new species of *Syncephalastrum*.................... P. C. MISRA 51
Soil microfungi of central and southern Ohio.
L. H. HUANG AND J. A. SCHMITT 55
The genus *Ostreichnion*...................... MARGARET E. BARR 81
Sarcinosporon: a new genus to accommodate *Trichosporon inkin* and *Prototheca filamenta*.......... D. S. KING AND S. C. JONG 89
Cortinarius, section *Dermocybe* – *Cortinarius clelandii*.
JOSEPH F. AMMIRATI 95
Physcia duplicorticata Weber & Thomson sp. nov. from California............ WILLIAM A. WEBER AND JOHN W. THOMSON 102
Scanning electron micrographs of ascospores of *Pachyella* (Discomycetes)......................... DONALD H. PFISTER 105
Electrophoretic characteristics of enzymes as a taxonomic criterion in the genus *Humicola*.
J. MOORHOUSE AND M. DE BERTOLDI 109
Revision of *Cercospora* species (Hyphomycetes) parasitic on *Psoralea*.............................. O. CONSTANTINESCU 119
Phialocephala gabalongii as a synonym of *Phialocephala humicola*......................... S. C. JONG AND E. E. DAVIS 126
Notes on Hyphomycetes. VIII. *Lylea*, a new genus.
G. MORGAN-JONES 129
Taxonomy and nomenclature notes on Uredinales... G. F. LAUNDON 133
Arthrobotrys entomopaga in pure culture.
J. E. ROXON AND S. C. JONG 162
Variation in Ascomycete iodine reactions: KOH pretreatment explored.................. LINDA M. KOHN AND RICHARD P. KORF 165
Studies on the lichen family Thelotremataceae. 3.
MASON E. HALE, JR. 173
Book Reviews.................................. G. L. HENNEBERT 182
Comments on the Scleromyceti Sueciae in the Farlow Herbarium.
DONALD H. PFISTER 185

[MYCOTAXON for July-September 1975 (2: 209-276)
was issued July 8, 1975]

ISSN 0093-4666 MYXNAE 3(1) 1-192 (1975)

Library of Congress Catalogue Card Number 74-7903

Published quarterly by MYCOTAXON, Ltd., P.O. Box 264, Ithaca, NY 14850
For subscription details, see back cover

MYCOTAXON

Vol. III, No. 1, pp. 1-50 October-December 1975

A TAXONOMIC REVISION OF THE PROTOMYCETALES[1]

M. SUGUNAKAR REDDY[2]

Department of Plant Pathology
Kansas State University, Manhattan, Kansas 66506

AND

CHARLES L. KRAMER

Division of Biology
Kansas State University, Manhattan, Kansas 66506

SUMMARY

Five genera, including the newly segregated genus *Burenia*, are recognized as members of the single family of the Protomycetales. Keys are provided to the genera and the nineteen recognized species, including one new species, of Protomycetales.

INTRODUCTION

From the time Unger (1833) described the first species of *Protomyces*, *P. macrosporus*, the taxonomic position of these fungi has remained uncertain. De Bary (1887) treated them as a group alongside the Ustilaginaceae, as did Ward

---

[1] Contribution No. 582, Department of Plant Pathology and No. 1192, Division of Biology, Kansas Agricultural Experiment Station. This study was supported in part by the Kansas Agricultural Experiment Station and NSF grant GB-14972.

[2] Present address: Department of Plant Pathology, College of Agriculture, Andhra Pradesh University, Rajendranagar, Hyderabad, India.

(1887) and Plowright (1889), connecting them through the Chytridiaceae to the Phycomycetes. Van Tieghem (as given in Sappin-Trouffy, 1897) in his Traite General de Botanique was the first to relate the characteristics of the Protomycetaceae to the Taphrinaceae. Brefeld and Tavel (1891) included *Ascoidea, Thelobolus* and *Protomyces* into a new group: Hemiasci, which they considered as a link between the Phycomycetes and the Ascomycetes. Popta (1899) however, did not include *Protomyces* in the Hemiasci, but clearly placed it among the higher Phycomycetes.

Considering the vesicle, within which the ascospores are produced, to be a synascus (a structure containing many asci without walls) von Buren (1922) agreed with Juel (1921) in linking the Hemiasci, *Protomyces, Protomycopsis, Volkartia* and *Taphridium* with the Taphrinaceae. Gäumann and Dodge (1928) treated the Taphrinaceae and Protomycetaceae as families of the order Taphrinales, based on the assumption that the ascogenous cells of Protomycetaceae are homologous to the ascogenous cells of the Taphrinaceae. Fitzpatrick (1930) disagreed; he considered the Protomycetaceae as having phycomycetous affinities. Bessey (1950) placed the group as an order in the Phycomycetes. Martin (1950) placed the Protomycetaceae as a family in the Taphrinales while Gäuman (1964) and Kramer (1973) treated the group as an order in the Hemiascomycetes.

Much of the confusion has resulted from the differences in opinion on the nature of the vesicle that is produced from thick walled, multinucleate resting spores (herein refered to as the ascogenous cells) in most species and on the formation of the ascospores. In addition, ascogenous cells generally have been referred to in the literature as chlamydospores, indicating an asexual function. However, in some species the walls are not thick, germination may occur without a rest period in some and those that have been studied cytologically are believed to be involved in a sexual phase (von Buren, 1915; Valadon *et al.*, 1962; Pavgi and Mukhopadhyay, 1970).

The Protomycetales have received little attention as a group and a full taxonomic treatment of them is lacking. The studies of von Buren (1915, 1922) did not consider the species on a worldwide basis. We reexamined all available material in light of existing knowledge and attempted to provide a basis and stimulation for further collection and study of these fungi.

Most studies, on which our discussions are based, have been conducted on only one or a few species. More extensive studies on ascospore formation, cytology, cell composition, cultural characters, nutritional physiology, pathogenicity and probable saprophytic stages in nature are needed for a better understanding of the inter- as well as intrarelationships of these organisms.

THE ORGANISM

Cytology and Endospore Formation

The first work on the cytology and development of *Protomyces* was done by Sappin-Trouffy (1897) and Popta (1899). However, it was von Buren (1915) who proposed the first concept regarding the nature of the vesicle. He assumed that nuclear fusion occurred in the young ascogenous cells (now known to occur in some species in conjugated ascospores) and that when the ascogenous cells germinated the diploid nuclei became located in a peripheral layer within the vesicle. He proposed that the diploid nuclei divided meiotically to produce four haploid ascospores and that each tetrad resulting from a single spore mother cell was homologous to an ascus. He referred to the tetrads as naked asci and to the entire vesicle as a synascus of many naked asci. This concept of ascospore formation and the nature of the vesicle has been confirmed by Pavgi and Mukhopadhyay (1970) for *Protomyces macrosporus*.

Establishment of Diplophase

Immediately following their liberation, ascospores may conjugate in pairs. Conjugation was observed by many earlier workers, including De Bary (1887), von Buren (1915) and Tubaki (1957). In 1962, Valadon *et al.*, demonstrated bipolar heterothallism in *Protomyces inundatus*, though nuclear fusion in the conjugated cells was not demonstrated microscopically until later (Venitt *et al.*, 1968). Both the haploid and diploid cells are capable of multiplying by budding in a yeastlike manner (Valadon *et al.*, 1962) similar to that in *Taphrina*. This yeastlike phase can be maintained easily in culture (Tubaki, 1957), but nothing is known about this stage in nature.

The Parasitic Phase

Working with haploid and diploid cultures of *Protomyces inundatus* Valadon *et al.* (1962) showed that only the fused ascospores or cells derived from them were infective, producing mycelium on the host surface (the mycelium eventually penetrating the epidermis). Unfused ascospores budded heavily without producing mycelium, so were incapable of penetration and infection. Von Buren (1915) observed spores producing a germ tube that penetrated directly between the epidermal cells but not through stomata.

The multinucleate septate mycelium (Fig. 1) invades the host tissues intercellularly penetrating throughout all tissues. Although tending to avoid xylem vessels, the mycelium commonly concentrates around the vascular bundles (von Buren, 1915).

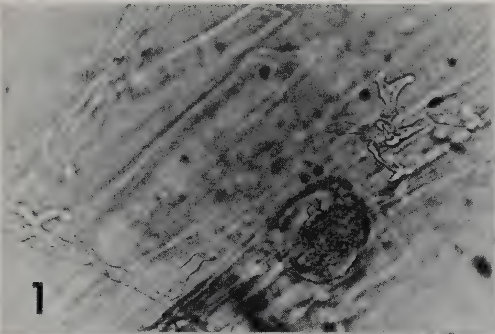
Hypertrophy and hyperplasia of the infected tissues generally results in the formation of distinct galls or swellings. Gall formation is most common in *Protomyces* and less common or absent in other genera. Leaves, stems, flowers, fruits and other aerial parts of plants may be infected, although some species of the fungus prefer certain host parts. Several species of *Protomyces* tend to localize along the veinlets, veins and midrib; occasionally they are responsible for blisterlike swellings in the interveinal areas of the leaf lamina. Species of *Protomycopsis* cause leaf spots which may be only slightly swollen. The genera *Taphridium* and *Volkartia* (except for *Taphridium cicutae*) cause lesions that may involve the entire leaf lamina.

Formation of Ascogenous Cells

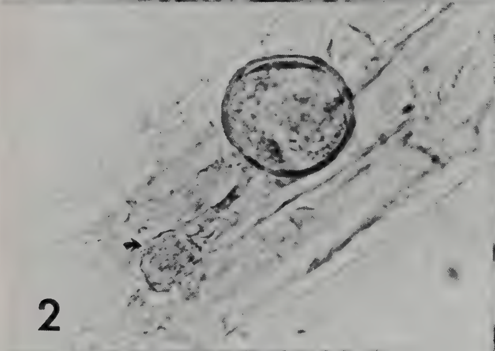
Ascogenous cells may be formed intercalaraly (Figs. 2-4) or terminally (Fig. 5) by enlargement of the mycelial cell which in most species is accompanied by the formation of a thick cell wall. The exact process by which walls of

---

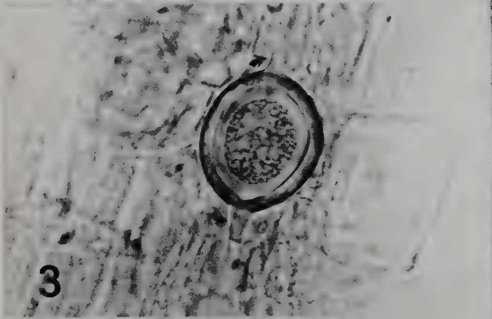
Figs. 1-7. 284X. 1, *Protomyces macrosporus*, hyphae. 2-3, *P. macrosporus* intercalary spore formation; 2, arrow indicates young spore; 3, arrows indicate hyphal fragments on either end. 4, *P. pachydermus*, intercalary spore formation. 5, *Protomycopsis belledis*, terminal spore formation. 6, *Protomyces macrosporus*: a. germinating ascogenous spore; b. vesicle. 7, *Volkartia rhaetica*, germinating ascogenous spore (a) and vesicle (b) with ascospores.



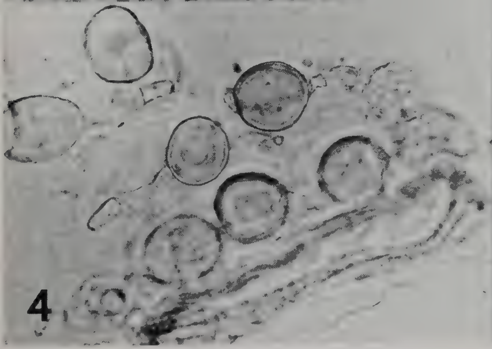
1



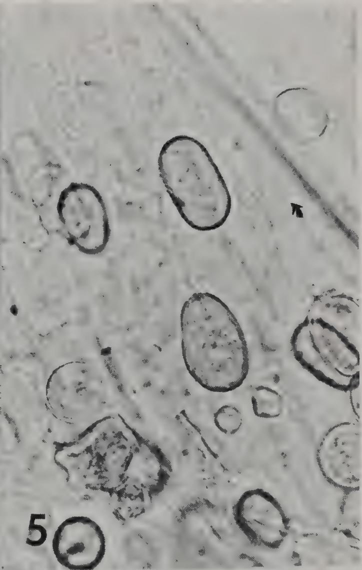
2



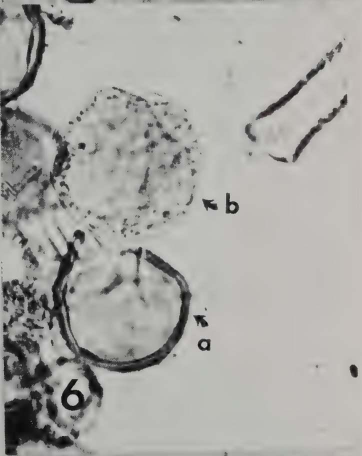
3



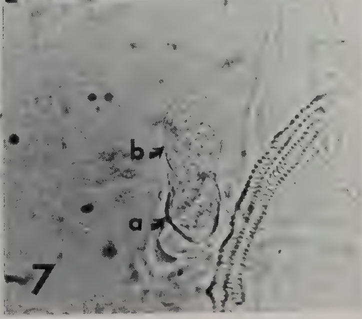
4



5



6



7

the ascogenous cells are formed, however, has not been demonstrated.

The ascogenous cells are spherical to subspherical but may be somewhat angular due to pressures from the surrounding host tissue. Average size ranges from 17 to 73 μ in diameter, although average diameter seems to be relatively constant for a given species.

In *Protomyces* and *Protomycopsis*, ascogenous cells occur scattered throughout the host tissues; in *Taphridium* (except for *Taphridium cicutae*) and *Volkartia*, ascogenous cells are produced in a single layer, usually just below the upper (rarely inside the lower) epidermis.

Opinions on the layers and thickness of ascogenous cell walls differ considerably. For *Protomyces*, Sappin-Trouffy (1897) described the wall as three layered. Von Buren (1915) referred to the layers as exosporium (generally thick), mesosporium (generally thin), and endosporium (of variable thickness). Most other workers have described the wall as two layered (Davis, 1907; Sawada, 1928). Because the so-called inner wall often has been interpreted as including a layer of peripheral cytoplasm (Davis, 1907), various wall thicknesses have been reported. Using the electron microscope, Nozu and Yamamoto (1970) demonstrated that the wall of *Protomyces inouyei* is composed of two layers. We found that the apparent increase in the thickness of the ascogenous cell wall in *Protomyces macrosporus* was proportionate to the length of time the specimen was boiled in water. The increase was still greater when ascogenous cells were boiled in KOH.

The ascogenous cells of all genera are unicellular and multinucleate, the number of nuclei per ascogenous cell being about 50 for *Protomyces macrosporus* (Pavgi and Mukhopadhyay, 1970) and 100 to 200 for *Protomyces inundatus* (Valadon *et al.*, 1962).

Ascogenous Cell Germination

In *Protomyces* and *Protomycopsis*, a rest period is required before the ascogenous cell will germinate. Tubaki (1957) found that seven months was required for three species of *Protomyces*. *Protomyces inundatus*, an exception, will germinate immediately, as will all species of *Taphridium* and *Volkartia* that have been studied.

When the ascogenous cell begins to germinate, the homogeneous protoplasm differentiates into a central and marginal zone followed first by the appearance of vacuoles in the central portion and gradually toward the marginal zone. In those species that form vesicles, the ascogenous cell wall splits, allowing the vesicle to protrude (Fig. 6). The wall of the vesicle is the so-called endosporium. The vacuoles then begin fusing from the center, finally resulting in a large central vacuole which forces the protoplast to become concentrated in a thin peripheral layer. The vesicle is fairly constant in shape and size in some species, but in others may vary in length as much as threefold (von Buren, 1915, 1922; Gupta and Singa, 1964; Tubaki, 1957).

Once the vesicle is fully extended, the nuclei become arranged in a single peripheral layer. Pavgi and Mukhopadhyay (1970) stated that in *Protomyces macrosporus* this is followed by "radial septation" resulting in a single layer of uninucleate cells each of which undergoes meiosis to produce four haploid spores. They reported the chromosome number in *P. macrosporus* was two ($n = 2$).

After they form, the ascospores accumulate at the apex of the vesicle. Not all the cytoplasm is used to form ascospores. The epiplasm functions in producing excessive turgor that causes the vesicle to rupture, ejecting the contents in a single mass (von Buren, 1915). As soon as the ascospores (measuring 4.5 x 3 µ in *P. macrosporus*) are liberated, they unite in pairs by protruding small appendages. Copulation of ascospores has been observed in the genera *Protomyces*, *Taphridium* and *Volkartia* (Maire, 1907) but not in *Protomycopsis* (Fitzpatrick, 1930).

In some species, vesicles are not produced. Instead ascospores are formed within the ascogenous cell (Juel, 1902; Dangeard, 1906; Valadon *et al.*, 1962). This type of germination is characteristic of species of *Taphridium* and the new genus described below. In *Volkartia*, germination also occurs immediately but a vesicle similar to that of *Protomyces* and *Protomycopsis* forms (Fig. 7). Maire (1907), who described *Volkartia*, found that the ascospores sometimes formed within the ascogenous cell before the rupture of the external wall and at other times in the vesicle. The arrangement of germinated ascogenous cells with vesicles filled with ascospores in the genus *Volkartia* resembles in appearance the ascogenous layer of asci in species of *Taphrina*.

Mixia differs from all these in that the wall of a multinucleate cell of the mycelium extends outward in the form of a papilla. There is no rupturing of the ascogenous cell wall and while the papilla is elongating, a columella forms delimiting the sporogenous protoplast from a sterile central portion. Whether or not ascospore formation is similar to that reported for *Protomyces* is not known.

Cell Wall Composition

Von Buren (1915) considered the cell walls of *Protomyces* to be composed of cellulose on the basis of the reaction with chloride of zinc. Valadon *et al.* (1962), considering this method of testing for cellulose being unreliable, determined the wall composition by chemical analysis. Working with *Protomyces inundatus*, they showed that the cell wall is composed of neither cellulose nor chitin but glucan, a polysaccharide also found in the cell wall of yeasts. In addition they also detected the presence of an alkali-soluble polysaccharide that produced mannose on hydrolysis, another similarity with cell wall composition of yeasts.

Host Specialization

The host range of these fungi is restricted: *Protomyces* occurs on Umbelliferae and Compositae; *Protomycopsis* on Compositae; *Taphridium* on Umbelliferae; and *Volkartia* on Compositae. *Mixia*, which is doubtfully placed here, occurs on the fern *Osmunda*.

Von Buren (1922) used the results of cross inoculation studies of various isolates on different host species to differentiate species and form-species of the pathogen. Several of the species he created, based on pathogenicity, are forms that are morphologically similar and produce identical symptoms on closely related hosts. Also, there have been many species described as members of the Protomycetales based primarily on pathogenicity that have been found to belong to other groups such as the Ustilaginales.

Gupta and Sinha (1964), who studied the variation in pathogenicity of several isolates of *Protomyces macrosporus* from *Coriandrum sativum* on several cultivars, recognized three categories in their isolates based on differential reaction.

TAXONOMY

ORDER PROTOMYCETALES

PROTOMYCETALES Gäumann, Die Pilze, Birkhauser Verlag, Basel und Stuttgart 107. 1964.

Fungi causing galls and lesions on stems, leaves, and petioles of higher plants. Mycelium intercellular, septate, and multinucleate in a diploid state. Ascocarp lacking. Thick-walled multinucleate ascogenous cells produced intercalaraly or terminally on the mycelium throughout the host tissues or in a single subepidermal layer; germinating either immediately or after a period of rest, with or without the production of a vesicle. Ascospores resulting from meiotic division of the diploid nuclei; in some the entire contents forcibly discharged; usually fusing in pairs; budding in a yeastlike manner; only diploid cells capable of infection.

FAMILY PROTOMYCETACEAE

PROTOMYCETACEAE De Bary in Saccardo, Syll. Fung. 17: 317. 1905.

There is a single family with the characters of the order.

KEY TO GENERA OF PROTOMYCETACEAE

1. Ascogenous cells formed throughout the tissues of the host 2
1. Ascogenous cells formed in a single layer beneath the host epidermis 4

2. Ascogenous cells forming ascospores without a rest period; vesicle not produced . . . . *BURENIA*
2. Ascogenous cells requiring a rest period before germinating to form a vesicle in which the ascospores are formed 3

3. Ascogenous cells produced intercalaraly, smooth walled . . . . *PROTOMYCES*
3. Ascogenous cells produced terminally, rough walled at least when young . . . . *PROTOMYCOPSIS*

4. Ascospores produced within the ascogenous cell; vesicle not produced . . . .*TAPHRIDIUM*
4. Ascospores produced within the ascogenous cell or inside the vesicle; vesicle always produced. *VOLKARTIA*

GENUS BURENIA

Burenia gen. nov.

Membra paracitica in Umbelliferis facientia pustulas tumores in caulibus v. in foliis. Cellula ascogenicae formulatae per telas; sphaericae v. ellipticae; laete flavido-brunneae; habentes parietes leves; statim germinates sine quite. Ascosporae in situ productis; non vesiculis productis.

Members parasitic on Umbelliferae causing blisters or swellings on stems and leaves. Ascogenous cells formed throughout the tissues; spherical to elliptical; light yellowish-brown; smooth-walled; germinate immediately without a rest period. Ascospores formed within the ascogenous cells; vesicle not produced.

TYPE SPECIES: *Taphridium cicutae* Lindroth

The two species for which this new genus has been created previously belonged to the genera *Protomyces* and *Taphridium*. The fungus referred to as *Protomyces inundatus* was first described as *P. macrosporus* (Sappin-Trouffy, 1897). However, in 1883, Phillips identified (without description) a specimen as *P. helosciadii*, which we examined and found to be identical to *P. inundatus*.

The drawing of the fungus in Sappin-Trouffy's paper clearly shows a different method of endospore formation than that of *P. macrosporus*. Because the ascogenous cell produces ascospores without a rest period, Dangeard (1906) proposed the name *P. inundatus*. Based on its *Taphridium*-like germination of the ascogenous cell, von Buren (1915) transferred the species to *Taphridium*. However, after finding that a few ascogenous cells also germinated in a *Protomyces*-like manner (producing ascospores within a vesicle after a period of rest), von Buren (1918) placed it back in *Protomyces*. Valadon *et al.* (1962), who studied the fungus intensively, found that all ascogenous cells germinated in a *Taphridium*-like manner.

The species hitherto referred to as *Taphridium cicutae* was described by Lindroth in 1904. The ascogenous cells of this species also germinate immediately without producing a vesicle. Juel (1921) who studied the genus *Taphridium* in detail, thought the species probably belonged to the genus *Protomyces* because it produced ascogenous cells throughout the tissues and not in a single subepidermal layer, as do species of *Taphridium*.

Like *Protomyces*, the two species here placed in the genus *Burenia*, produce ascogenous cells throughout the host tissues and their ascogenous cells germinate in a *Taphridium*-like manner. Because they have characteristics clearly different from those of both *Protomyces* and *Taphridium*, we placed them in a new genus *Burenia* named after G. von Buren, who for more than half a century has contributed greatly to our knowledge of this group.

KEY TO THE SPECIES OF BURENIA

1. Ascogenous cells 55(37-73) x 63(37-100) μ; parasitic on species of *Cicuta* . . . . *B. cicuta*
1. Ascogenous cells 47(30-56) μ; parasitic on species of *Apium*, *Daucus* and *Sium*. . . . . *B. inundata*

1. *Burenia cicuta* (Lindroth) Reddy & Kramer, comb. nov.

BASIONYM: *Taphridium cicutae* Lindroth, Acta Societatis pro Fauna et Flora Fennia 26(5): 9. 1904.

ILLUSTRATIONS: Figs. 8-11.

Pustules at the base or tip of the petiole; round, elliptical to elongate. Ascogenous spores spherical to elliptical; 55(37-74) x 63 (37-100) μ. Ascospores 4-7 x 1-2 μ; fusion of ascospores not observed.

HOST GENUS: *Cicuta*

DISTRIBUTION: Europe: Finland, U.S.S.R.

2. *Burenia inundata* (Dangeard) Reddy & Kramer, comb. nov.

SYNONYM: *Protomyces helosciadii* Phillips, 1883, nom. nudum
BASIONYM: *Protomyces inundatus* Dangeard, Le Botaniste 9: 274. 1906.
SYNONYM: *Taphridium inundatus* (Dangeard) von Buren, Beitr. Kryptfl. Schweiz 5(1): 29. 1915.

ILLUSTRATIONS: Figs. 12-16.

Small blister-like warts on leaves. Ascogenous cells spherical to roughly spherical, 47(30-56) μ; light brown. Ascospores usually produced within the ascogenous cells which do not undergo a rest period; following release, fusing in pairs.

HOST GENERA: *Apium, Daucus, Sium*

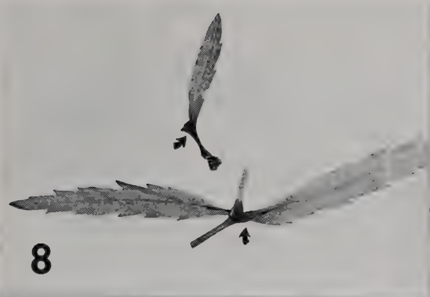
DISTRIBUTION: Europe: England, France, W. Germany, Switzerland

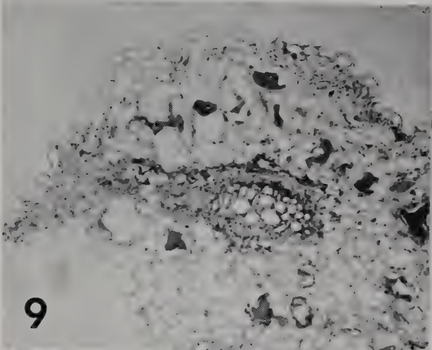
OBSERVATIONS: A collection on *Sium latifolium* L. (France, May 1884, J. Therry, 3025 (N.Y.) originally reported as a host for *Protomyces macrosporus*, was found instead to host *Burenia inundata*. From this it seems likely that *Sium erectum* Huds., also a reported host for *P. macrosporus* of which specimens have been unavailable, is similarly a host of *B. inundata*.

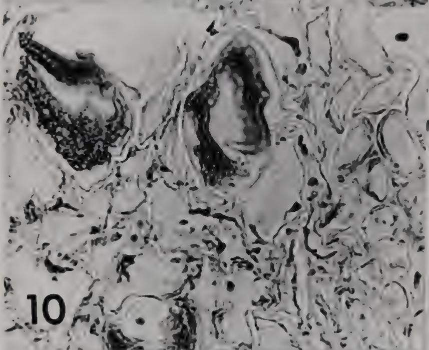
GENUS PROTOMYCES

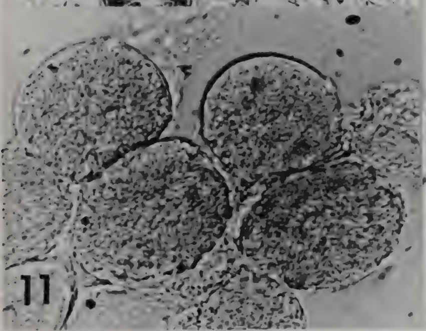
Protomyces Unger, Die Exantheme der Pflanzen Wien 341. 1833.

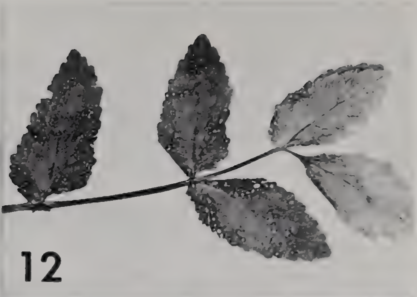
Figs. 8-11. *Burenia cicuta*: 8, pustules on petioles of *Cicuta virosa* (arrows); 9-10, cross section of pustule (9. 73X, 10. 284X); 11, ascospores formed within ascogenous cells, slide prepared from teased material. Figs. 12-16. *Burenia inundata*: 12, blisters on leaves of *Apium nodiflorum*; 13-14, cross section of blister showing germination of ascogenous cells (13. 73X, 14. part shown by arrow in 13, 284X); 15, ascogenous cell from teased material, 284X; 16, ascospores formed within ascogenous cells, from teased material, 284X.

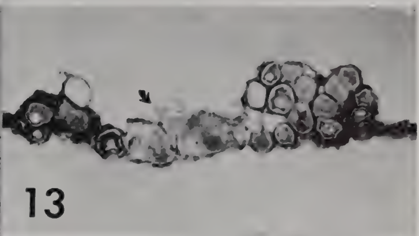

8

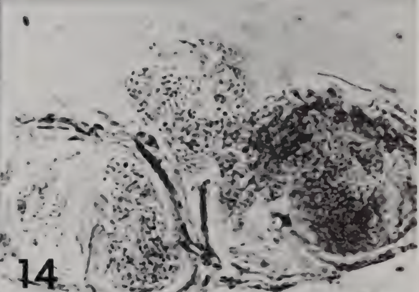

9

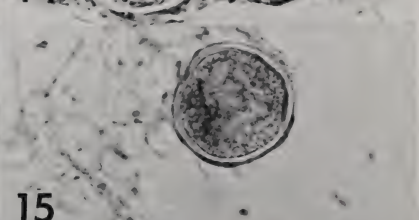

10

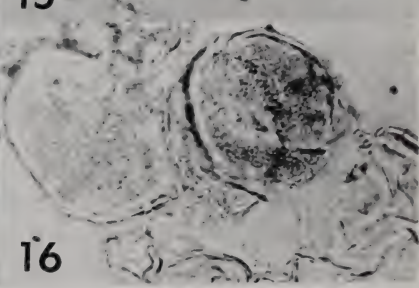

11


12


13


14


15


16

Parasitic on species of Compositae and Umbelliferae; galls on stems, leaves, flowers, and fruits; on leaves galls usually restricted to petiole, midrib, veins, and veinlets; hypertrophy and hyperplasia occurring in various degrees. Ascogenous cells occurring intercalaraly in the intercellular mycelium throughout the infected tissues; spherical to subspherical, rarely broadly ellipsoidal; walls pale to light yellowish-brown, thick and smooth (rough in *P. inouyei*); germinating on overwintered remains of host by forming vesicles. Numerous haploid ascospores produced in the vesicle; following release, ascospores fusing in pairs.

TYPE SPECIES: *Protomyces macrosporus* Unger

KEY TO SPECIES OF PROTOMYCES BASED ON HOST GENERA

UMBELLIFERAE:

Host genera include: *Aegopodium, Ammi, Angelica, Anthriscus, Archangelica, Athamanta, Canopodium, Carum, Caucalis, Chaerophyllum, Coriandrum, Ferula, Heracleum, Hydrocotyle, Laserpitium, Ligusticum, Meum, Onanthe, Pancicia, Parum, Peucedanum, Pimpinella, Seseli, Silaus, Thapsia,* and *Trinia.*

Ascogenous cells 51(37-74) μ; small to medium galls on stems, leaves, flowers, and fruits; Europe, S. Asia and N. Africa. . . . . *P. macrosporus*

COMPOSITAE:

Ambrosia

Ascogenous cells 65(48-83) x 73(52-85) μ; large galls on stem; N. America . . . . . *P. grandisporus*

Ascogenous cells 37(30-52) μ; large galls usually on stems; N. America. . . . . *P. gravidus*

Aposeris

Ascogenous cells 36(26-52) μ; swellings on midrib, veins, and veinlets; Europe, Israel and Japan . . . . *P. pachydermus*

Bidens

Ascogenous cells 59(48-74) x 63(48-74) µ; large galls on stems; S. America. . . . . *P. andinus*
Ascogenous cells 37(30-52) µ; large galls usually on stems; N. America and Europe. . . . . . *P. gravidus*

Centaurea

Ascogenous cells 36(26-52) µ; swellings on midrib, veins, and veinlets; Europe . . . . . *P. pachydermus*

Crepis

Ascogenous cells 36(26-52) µ, walls smooth; swellings on midrib and veins; Europe . . . . . *P. pachydermus*
Ascogenous cells 38(33-48) µ, walls rough; swellings on leaves and large galls on stems and petioles; Japan . . . . *P. inouyei*

Galinsoga

Ascogenous cells 54(33-67) x 58(44-78) µ; large linear galls on stems and leaves; Europe . . . . *P. burenianus*

Hyoseris

Ascogenous cells 36(26-52) µ; swellings on midrib, veins, and veinlets; Europe . . . . . *P. pachydermus*

Hypochoeris

Ascogenous cells 59(48-74) x 63(48-74) µ; large galls on stems and small galls on leaves; S. America . . . . *P. andinus*
Ascogenous cells 36(26-52) µ; swellings on midrib, veins and veinlets; Europe. . . . . . *P. pachydermus*

Lactuca

Ascogenous cells 44(37-63) µ; twisting and large gall formation on stems, leaves, and petioles; Japan and Taiwan. . . . . *P. lactucae-debilis*

Leontodon

Ascogenous cells 36(26-52) µ; swellings on midrib, veins, and veinlets; Europe . . . . *P. pachydermus*

Matricaria

Ascogenous cells 41(30-52) μ; galls on stems and leaves; Europe. . . . . *P. matricariae*

Picris

Ascogenous cells 36(26-52) μ; swellings on midrib, veins, and veinlets; Europe . . . . *P. pachydermus*

Sonchus

Ascogenous cells 37(26-48) μ; large galls on stems; Europe including U.S.S.R. . . . . *P. sonchi*

Taraxacum

Ascogenous cells 36(26-52) μ; swellings on midrib, veins, and veinlets; Europe, Asia and N. America . . . . *P. pachydermus*

1. *Protomyces andinus* Patouillard in Patouillard, N. & G. Lagerheim, Bull. Soc. Mycol. France 8:124. 1892.

SYNONYM: *Protomyces giganteus* Schroter in P. Hennings, Hedwigia 35:212. 1896.

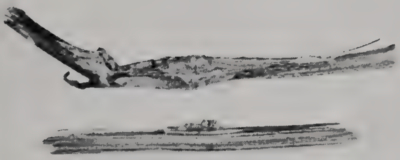
ILLUSTRATIONS: Figs. 17-20.

Large galls on stems and small galls on petioles and midrib. Ascogenous cells numerous, spherical to elliptical, 59(48-74) x 63(48-74) μ, light yellowish-brown, germination not observed.

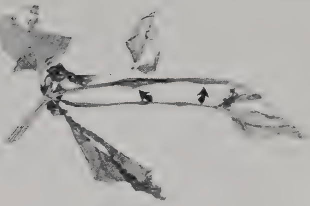
HOST GENERA: *Bidens, Hypochoeris*

DISTRIBUTION: S. America: Ecuador, Brazil.

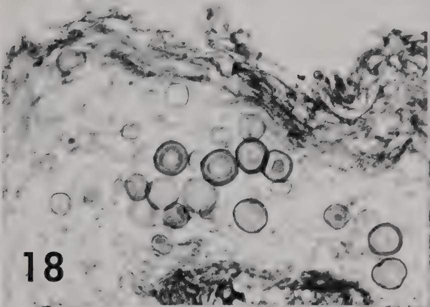
Figs. 17-20. *Protomyces andinus*: 17, galls on stems of *Bidens andicola*; 18-19, cross section of the gall (18. 73X; 19. 284X); 20, teased ascogenous cells, 284X. Figs. 21-24. *Protomyces burenianus*: 21, galls on stems of *Galinsoga parviflora*; 22-23, cross section of the gall (22, 73X; 23, 284X); 24, teased ascogenous cells, 284X.



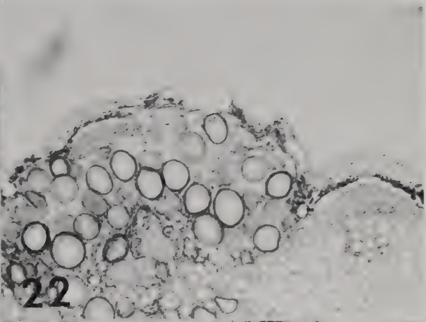
17



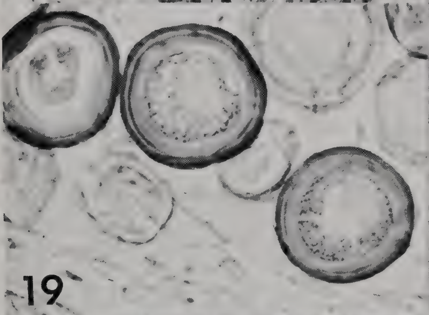
21



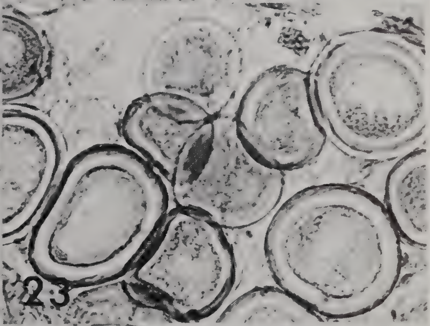
18



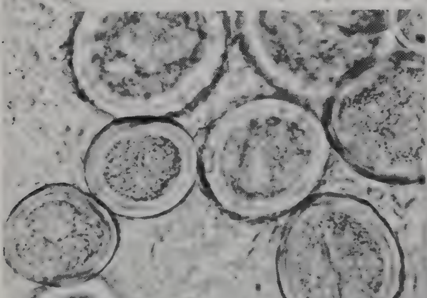
22



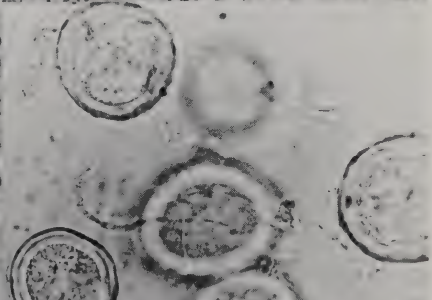
19



23



20



24

OBSERVATIONS: Based on ascogenous cell measurements and distribution, *P. giganteus* is considered synonymous to *P. andinus*. K. Sawada (1922) described the species *P. bidentis* on *Bidens pilosa* L. but neither description nor specimens could be obtained.

2. *Protomyces burenianus* Buhr, Phytopath. Zeit. 15:405. 1949.

ILLUSTRATIONS: Figs. 21-24.

Galls on stems, leaves (? and occasionally roots). Ascogenous cells spherical to broadly elliptical, 54(33-67) x 58(44-78) μ, light yellowish-brown, germination not observed.

HOST GENUS: *Galinsoga*

DISTRIBUTION: Europe: E. Germany, W. Germany, Poland, Switzerland.

OBSERVATIONS: Based on host, ascogenous cell measurements and distribution, *Protomyces wodziczkoi* Szul. (whose speciments were not available for examination) could be synonymous with *P. burenianus*.

3. *Protomyces grandisporus*, sp. nov.

ILLUSTRATIONS: Figs. 25-28.

Gallae magnae in caulibus. Cellula ascogenicae multae, sphaericae v. ellipticae, magnae 68(48-83) x 78(52-85) μ, laete flavido-brunneae.

Galls large on stems. Ascogenous cells numerous, spherical to elliptical, large, 65(48-83) x 78(52-85) μ, light yellowish-brown; germination not observed.

HOLOTYPE: Wisconsin (U.S.A.), 13.9. 1907, J. J. Davis (WIS).

HOST GENUS: *Ambrosia*

DISTRIBUTION: N. America: Oregon, Wisconsin, Pennsylvania

OBSERVATIONS: All collections on *Ambrosia* and *Bidens* have been identified either as *Protomyces andinus* or *Protomyces gravidus*, irrespective of vast differences in spore sizes. We studied a number of specimens carefully, and a pattern evolved indicating three distinct species exist: (1) *Protomyces andinus* parasitizing *Bidens andicola* in Ecuador, S. America, with ascogenous cells measuring 59(48-74) x 63 (48-74) μ; (2) *Protomyces gravidus* parasitizing *Ambrosia artemisaefolia, A. trifida, Bidens cernua, B. cannata* and *B. frondosa* in N. America and Europe (only one specimen), with ascogenous cells measuring 37(30-52) μ; and, (3) *Protomyces grandisporus* parasitizing only *Ambrosia artemisaefolia* in N. America, with the largest ascogenous cells within the genus *Protomyces* measuring 65(48-83) x 73(52-85) μ.

4. *Protomyces gravidus* Davis, Jour. Mycol. 13:188. 1907.

ILLUSTRATIONS: Figs. 29-32.

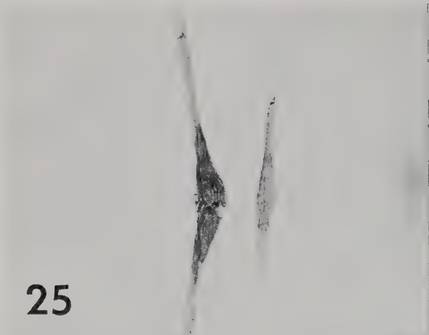
Large hypertrophic galls mostly on stems, occasionally on petioles and midrib. Ascogenous cells spherical to subspherical, 37(30-52) μ, germination not observed.

HOST GENERA: *Ambrosia* and *Bidens*

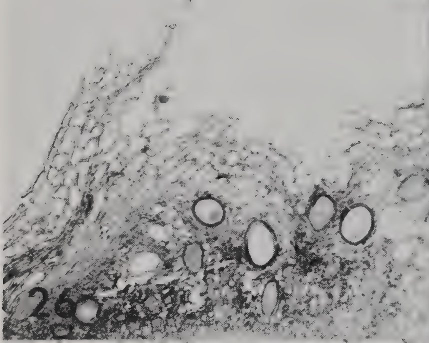
DISTRIBUTION: N. America: New York, Wisconsin; Europe: Finland.

5. *Protomyces inouyei* Hennings, Engler's Botan. Jahrb. 32: 34. 1902.

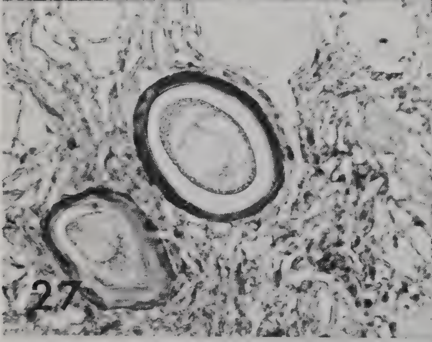
Figs. 25-28. *Protomyces grandisporus*: 25, galls on stems of *Ambrosia artemisaefolia*; 26-27, cross section of the gall (26. 73X; 27. 284X); 28, teased ascogenous cells, 284X. Figs. 29-32. *Protomyces gravidus*: 29, galls on stems of *Ambrosia trifida*; 30-31, cross section of the gall (30, 73X; 31, 284X); 32, teased ascogenous cells, 284X.



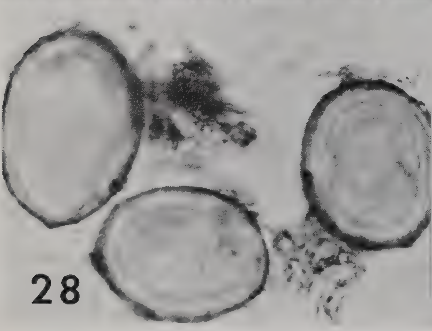
25



26

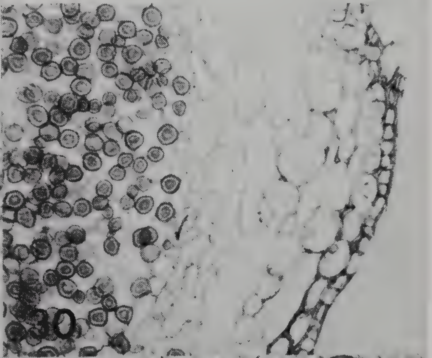


27



28

29



30

31

32

ILLUSTRATIONS: Figs. 33-36.

Extensive galls on stems and petioles; leaves when attacked become crinkled. Ascogenous cells spherical with rugulose walls, 38(33-48) μ, light brown. Vesicles 25-45 x 55-145 μ.

HOST GENUS: *Crepis*

DISTRIBUTION: Asia: Japan

OBSERVATIONS: The rough walled ascogenous spores indicate a relationship with *Protomycopsis*, yet because of their intercalary production, this species is retained in *Protomyces*.

6. *Protomyces lactucae-debilis* Sawada, Descriptive Catalogue of the Formosan Fungi 4:19. 1922.

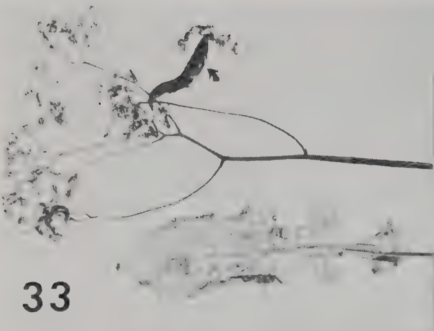
Swellings and galls on stems, buds, and leaves; leaves when infected curl and other parts may be twisted. Ascogenous cells roughly spherical, 44(37-63) μ, light yellow. Vesicles 20-40 x 100-280 μ.

HOST: *Lactuca debilis* Benth. & Hook.

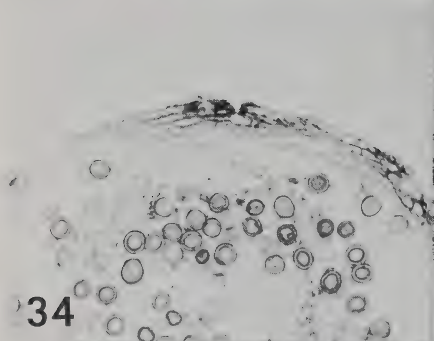
DISTRIBUTION: Asia: Japan, Taiwan

Material of this species was unavailable for study. Description and records are taken from the literature. *Protomyces lactucae* Sawada and *P. ixeridis-oldhami* Sawada may be synonymous to *P. lactucae-debilis* because of the apparent similarities in spore measurements, hosts, and distribution. However, because specimens could not be obtained, the question remains open.

Figs. 33-36. *Protomyces inouyei*: 33, gall on stem of *Crepis japonica* (arrow); 34, cross section of gall, 73X; 35, cross section of gall showing rugulose wall of the ascogenous cells, 284X; 36, teased ascogenous cells with rugulose walls, 284X. Figs. 37-40. *Protomyces macrosporus*: 37, galls on leaf veins (a) and stem (b) of *Aegopodium podagravia*; 38-39, cross section of the gall (38. 73X; 39. 284X); 40, teased ascogenous cells, 284X.



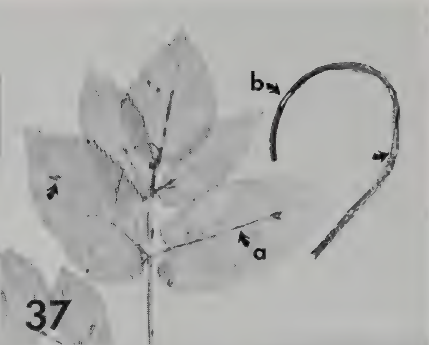
33



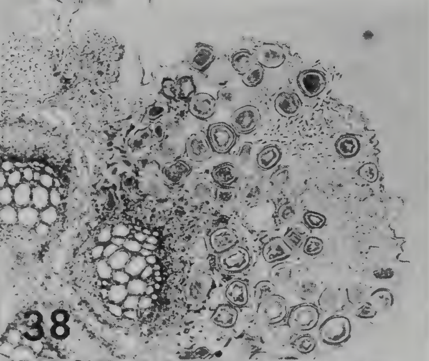
34

35

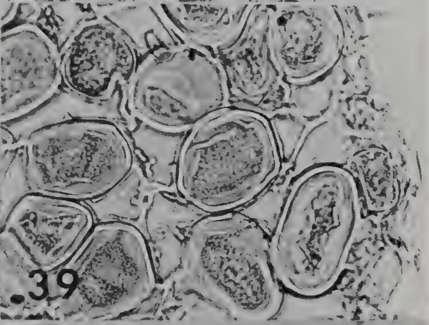
36



37



38



39

40

7. *Protomyces macrosporus* Unger, Die Exanth. der Pflanzen 344: 1833.

SYNONYMS: *Physoderma gibbosum* Wallroth, Flora Cryptog. Germaniae 192. 1833.
Protomyces cari Blytt, Forh Vidensk-Selsk. Christ 6: 77. 1896.

ILLUSTRATIONS: Figs. 37-40

Galls on stems, petioles, leaves, pedicels, and fruits of Umbelliferae; when on leaves galls mostly in veins, rarely in interveinal areas. Ascogenous cells spherical to roughly spherical, 51(37-74) μ, light yellowish brown. Ascospores cylindrical to oblong, 4.5 x 3 μ.

HOST GENERA: *Aegopodium, Ammi, Angelica, Anthriscus, Archangelia, Athamanta, Canopodium, Carum, Caucalis, Chaerophyllum, Coriandrum, Ferula, Heracleum, Hydrocotyle, Laserpitium, Ligusticum, Meum, Onanthe, Pancicia, Parum, Peucedanum, Pimpinella, Seseli, Silaus, Thapsia,* and *Trinia.*

DISTRIBUTION: Asia: India, Nepal, Pakistan; Europe: Austria, Belgium, Bulgaria, Czechoslovakia, Denmark, England, Finland, France, East and West Germany, Hungary, Ireland, Malta, Netherlands, Italy, Norway, Poland, Scotland, Sweden, Switzerland, Wales, Yugoslavia; N. Africa: Algeria

Specimens of the following genera reported as hosts of *Protomyces macrosporus* were not available for study: *Conopodium, Ovanthe* and *Pimpinella.*

8. *Protomyces matricariae* Sydow, Ann. Mycol. 30:96. 1932.

ILLUSTRATIONS: Figs. 41-44

Galls on stems and leaves. Ascogenous cells spherical to subspherical, 41(30-52) μ, light yellowish-brown, germination not observed.

HOST GENUS: *Matricaria*

DISTRIBUTION: Europe: W. Germany

9. *Protomyces pachydermus* Thumen, Hedwigia 13:97. 1874.

SYNONYMS: *Protomyces kreuthensis* Kuhn, Hedwigia 124. 1877.
Protomyces centaurea Lagerheim. Publication not known (specimen examined collected by G. Lagerheim, July 1896, Sweden (K), marked TYPE).
Protomycopsis crepidis Jaap. Ann. Mycol. 6: 204. 1908.
Protomyces crepidis von Buren, Beitr. Kryptfl. Schweiz 5(1):83. 1915.
Protomyces crepidicola von Buren, Beitr. Kryptfl. Schweiz 5(3):57. 1922.
Protomyces crepidis-paludosae von Buren, Beitr. Kryptfl. Schweiz 5(3):58. 1922.
Protomyces picridis von Buren, Beitr. Kryptfl. Schweiz 5(3):57. 1922.
Protomyces kriegarianus von Buren, Beitr. Kryptfl. Schweiz 5(3):57. 1922.
Protomyces crisii-oleracei Buhr, Archiv Des Vereins Der Freunde Der Naturgeschichte in Mecklunburg 40. 1936.

ILLUSTRATIONS: Figs. 45-48.

Swellings on petiole, midrib, veins, and veinlets, often forming a network of swollen veins and veinlets; sometimes the infected parts turning brown to reddish. Ascogenous cells spherical to roughly spherical, 36(26-52) μ, light yellowish-brown. Vesicles 30-60 x 45-150 μ.

HOST GENERA: *Aposeris, Centaurea, Crepis, Criseum, Hyoseris, Hypochoeris, Leontodon, Picris* and *Taraxacum*

DISTRIBUTION: Asia: Israel, Japan; Europe: Austria, Czechoslovakia, Denmark, England, E. and W. Germany, Iceland, Italy, Scotland, Sweden, Switzerland, Yugoslavia; N. America: Canada, Utah.

A species of *Protomyces* with a description resembling *Protomyces pachydermus* has been reported on *Cephalorynchus hispidus* (Magnus, 1896). Although this collection was not seen, *Cephalorynchus* is probably another host for *Protomyces pachydermus*.

OBSERVATIONS: G. von Buren (1915, 1922) created *Protomyces crepidis, P. crepidicola, P. crepidis-paludosa, P. picridis*, and *P. kriegerianus*, all of which resemble *P. pachydermus*, on the basis of differences seen in pathogenicity studies and vesicle sizes. However, it is now believed that these and other synonyms of *P. pachydermus* mentioned herein resemble each other so closely in ascogenous cell measurements, host range, symptoms, and distribution that they are considered one and the same. Although von Buren (1915, 1922) has shown vesicle size to be a constant factor for some species, for others he has recorded a wide variation. Considerable variation in vesicle size is reported for *P. pachydermus* (von Buren, 1922) and *P. crepidis* (von Buren, 1915). Similarly, variations in size are reported by Tubaki (1957) for *P. pachydermus* and two other species. Therefore, it is assumed that vesicle size is variable, not suitable as a taxonomic character. The various shapes and sizes of vesicles in the species that are now considered synonymous to *P. pachydermus* fall mostly within the range found in *P. pachydermus*.

Protomyces helminthae Maire could be synonymous with *Protomyces pachydermus* based on symptoms, host genus, and ascogenous cell measurements. As the specimens were not available for study, the question remains open.

10. *Protomyces sonchi* Lindfors, Svensk Botanisk Tidskrift. 12(2):224. 1918.

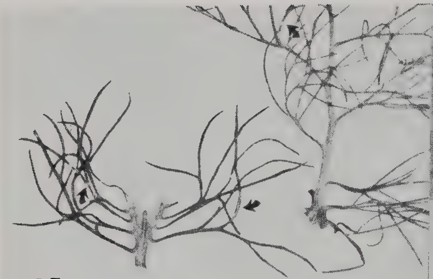
ILLUSTRATIONS: Figs. 49-52.

Galls large on stems. Ascogenous cells spherical to subspherical, 37(26-48) μ, light yellowish-brown; vesicle 50 μ long.

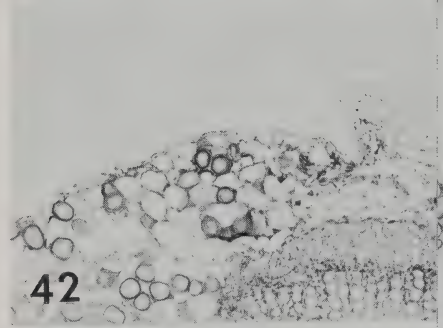
HOST GENUS: *Sonchus*

DISTRIBUTION: Europe including U.S.S.R.

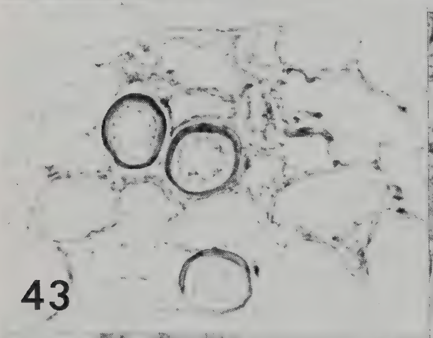
Figs. 41-44. *Protomyces matricariae*: 41, small galls on leaves of *Matricaria inodora* (arrows); 42-43, cross section of gall (42, 73X; 43, 284X); 44, teased ascogenous cells, 284X. Figs. 45-48. *Protomyces pachydermus*: 45, swollen veins of *Aposeris foetida*; 46-47, cross section of swollen vein (46, 73X; 47, 284X); 48, teased ascogenous cells, 284X.



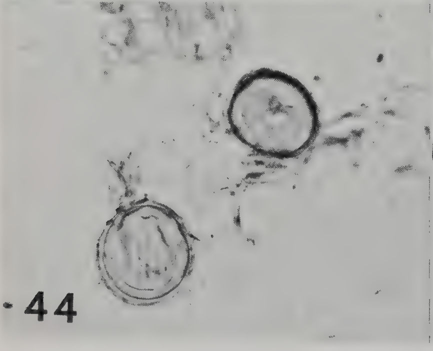
41



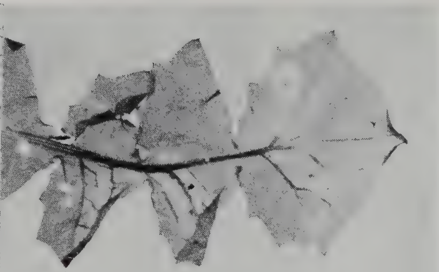
42



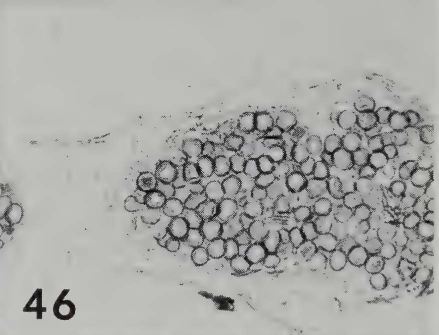
43



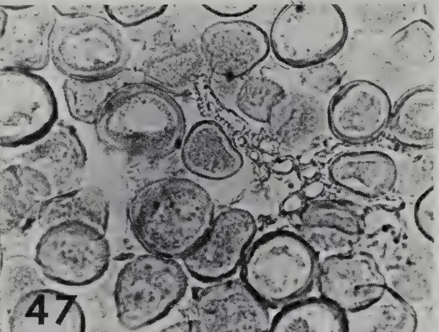
44



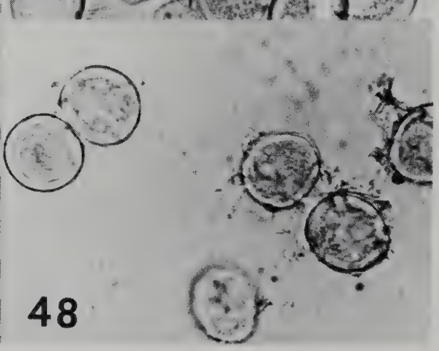
45



46



47



48

SPECIES UNAVAILABLE FOR STUDY

The following species listed here were not available for study and germination of ascogenous cells has not been reported in the literature. It is believed that most, if not all, of these species will be assigned as synonyms of existing species when material becomes available for study.

Protomyces bidentis Sawada, Descriptive Catalogue of the Formosan Fungi 3:53. 1922.

HOST: *Bidens pilosa* L.

DISTRIBUTION: Taiwan

No description available; Sawada's (1922) publication could not be obtained. However, two other species of *Protomyces*, *P. andinus* and *P. gravidus*, are parasitic on species of *Bidens*.

Protomyces helminthae Maire, Bull. de la Soc. d'Hist. Nat. de l'Afrique du Nord 6:255. 1914.

HOST: *Helminthae echioides* (=*Picris echioides* L.)

DISTRIBUTION: N. Africa: Tunisia

Based on the symptoms, host, and ascogenous cell measurements, this species seems to be synonymous with *Protomyces pachydermus*.

Protomyces ixeridis-oldhami Sawada, Trans. Nat. Hist. Soc. Formosa 32:130. 1942.

HOST: *Ixeris oldhami* Kitamura (=*Lactuca thumbergii* Maxim.)

DISTRIBUTION: Taiwan

This species seems to be synonymous with *Protomyces lactucae-debilis*, based on the host, distribution, and ascogenous cell measurements.

Protomyces lactucae Sawada, Descriptive Catalogue of the Formosan Fungi 4:18. 1928.

HOST: *Lactuca* sp.

DISTRIBUTION: Taiwan

It is likely that this species is synonymous with *Protomyces lactucae-debilis* because of the similarities in host group, distribution, and ascogenous cell measurements.

Protomyces wodziczkoi Szulczewski, Octa Soc. Bot. Polon 21:191. 1951.

HOST: *Galinsoga parviflora* Cavada

DISTRIBUTION: Poland

Because of the same host species, ascogenous cell measurements, and distribution, this species seems to be synonymous with *Protomyces burenianus*.

EXCLUDED OR DOUBTFUL SPECIES OF PROTOMYCES

Protomyces ari Cooke, Grevillea 1:7. 1872. = *Melanotaenium ari* (Cooke) Lagerheim.

Protomyces bizzozerianus Saccardo, Michelia 1:14. 1879. = *Doassansia sagittariae* (West) Fischer.

Protomyces calendulae Oudeman, Oud. Arch. Neerl. 8: 384. 1877. = *Entyloma calendulae* (Oud.) De Bary.

Protomyces calthae, name taken from specimen: Fungi ross. Coll. F. Bucholtz, 7.5. 1908, 1589 (FH). Spores are small (29 μ), not typical of *Protomyces*; publication and host name not known.

Protomyces carpogenus Saccardo, Michelia 1:118. 1879. Although specimens have not been seen, the reported size of the spores (18-20 μ) is probably too small for *Protomyces* and the host, which belongs to the Curcurbitae, seems unlikely for a member of this group.

Protomyces centelli Ciferri, Arkiv fur Botanik 23(14): 26. 1931. Parasitizes *Centella (Hydrocotyle) asiatica*, which is a host for *Protomyces macrosporus*. In this case symptoms (yellowish, dry spots resulting in shot holes) do not resemble those of *Protomyces*, and the spore size is small (20-40 μ). Specimens not seen.

Protomyces chrysoplenii Berkeley & Broome, Annals of Natural History 15:36. 1875. = *Entyloma chrysoplenii* Schroter

Protomyces? cocae Spegazzini, Annals Sociedad Cientifica Argentina 90:29. 1920. The description of this species does not indicate a species of Protomycetaceae. In addition its reported host, a species of Erythroxilaceae, is not known to be a host of this group. Specimens not seen.

Protomyces comari Berkeley & White, Ann. Nat. Hist. Ser. V 1:27 1878. = *Doassansia comari* De Toni

Protomyces concomitans Berkeley, The Gardeners Chro icle 392. Sep. 23. 1882. The orchid, reported as host of this species, is an unlikely host for a member of the Protomycetaceae. Specimens not seen.

Protomyces conglomeratus Peck, Annual Report of the State Botanist of the State Museum of New York. 32: 39. 1879. This species is parasitic on Chenopodiaceae, which is an unlikely host for species of Protomycetaceae. Specimens not seen.

Protomyces corticola Karsten, Meddel of Societas pro Fauna et Flora Fennica 11:146. 1884. The spores of this species appear to be too small (15-30 µ) for *Protomyces* and the host, *Betula alba*, has not been reported for Protomycetaceae. Specimens not seen.

Protomyces cyrenaicus Parisi, Naples, Universita Orto Botanico Bulletino 9:56. 1929. Spores are too small (12-14 µ) for *Protomyces* and the host, a species of Thelogonaceae, appears unlikely for Protomycetaceae. Specimens not seen.

Protomyces endogenus Unger, Die Exanth. der Pflanzen 342. 1833. = *Melanotaenium endogenum* (Unger) De Bary.

Protomyces eryngii Fuckel, Symb. Mycol. 75. 1869. = *Entyloma eryngii* (Corda) De Bary.

Protomyces erythronii Peck, Twenty-fifth Annual Report of State Botanist of State Museum, of the State of New York 90. 1872. Differs from members of Protomycetaceae in many ways. The host is a species of Liliaceae.

Protomyces fallax Saccardo, Michelia 1:118. 1879. Spores appear to be too small (16-20 µ) for *Protomyces*, and the host, a species of Pinaceae, appears unlikely for *Protomyces*. Specimens not seen.

SEE ERRATA

Protomyces? fallax Saccardo, Syll. Fung. 7:320 -- var. *albellinensis* Saccardo in Saccardo (E. Trotter) I Funghi dell' Avellinese, Avellino 108. 1920. Spores too small (15-19 μ) for *Protomyces*, and the host, a species of Pinaceae seems unlikely for *Protomyces*. Specimens not seen.

Protomyces fergussoni Berkeley & Broome, Annals of Natural History 15(1): 36. 1875. = *Entyloma fergussoni* (Berkeley & Broome) Plowright.

Protomyces ficariae Cornu & Roze, Bull. Soc. Bot. De France 22:161. 1874. = *Entyloma ranunculi* Schroter.

Protomyces? filicinus Niessl. in P. Magnus, Estratto dagli Atti del Congresso Botanico Internationale 1892. 1. 1893. = *Hyalospora polypodii* Magnus.

Protomyces fuscus Peck, Thirty-first Annual Report of the New York State Museum of Natural History 27, 1879. Differs from members of Protomycetaceae in many respects. The host is a species of Ranunculaceae.

Protomyces? gaillardiae Spegazzini, Museo Nacional de Buenos Aires 19:284. 1909. Although specimens have not been seen, Spegazzini suspected that the "spores" of this species could be oospores of *Albugo* or Peronosporaceae.

Protomyces gallii Nees., Das Syst. d. Pilze 10. 1837. = *Melanotaenium endogenum* (Unger) De Bary.

Protomyces graminicola Saccardo, Nuovo Giornale Botanico Italiano 8:172. 1876. = *Sclerospora graminicola* (Sacc.) Schroter.

Protomyces helocharidis Fuckel, Symb. Myc. 75. 1869. = *Cladochytrium helocharidis* Busgen.

Protomyces hispanicus Ciferri, Atti dell institutio botanico della R. Universita di Paris. Milan Ser 2 and 3:12. 1925. Symptoms unlike those of Protomycetaceae; the host is a species of Ranunculaceae. Specimens not seen.

Protomyces kemneri Lindfors, Svensk Botanisk Tidskrift 12(2):226. 1918. Although the description might indicate *Burenia*, symptoms differ and spores are brown. The host, a species of Leguminosae, appears unlikely for Protomycetaceae. Specimens not seen.

Protomyces leniaris Peck. Name taken from specimen and apparently not published: Herbarium New York State Museum, Aug. 1925, C. H. Peck (WIS). Symptoms differ from those of *Protomyces* species, and host is a member of Cyperaceae. No spores were found in the specimen.

Protomyces limnanthemii Ciferri, Arkiv for Botanik 23(14):25. 1931. This species differs in symptoms from *Protomyces*, and the host, a species of *Limnanthemum* appears unlikely for Protomycetaceae. Specimen seen had no spores.

Protomyces limosellae Kunze, Rabenh., Fungi Europe 1694. 1873. = *Doassansia limosellae* Schroter.

Protomyces macularis (Wallr.) Fuckel, Symb. Myc. 75. 1869. = *Doassansia alismatis* (Nees.) Cornu.

Protomyces martianoffianus Thumen, Bulletin de la Society imperiales des Naturalists de Moscou, Moscow 53:207. 1878. = *Doassansia martianoffiana* (Thum.) Schroter.

Protomyces martindalei Peck, Bull. Torrey Bot. Club 5: 2. 1874. Spores are too small (18 μ) for *Protomyces*, and the host, *Cuscuta gronovii* Willd. appears unlikely for Protomycetaceae.

Protomyces melanodes Berkeley & Broome, Annals of Natural History Ser. 5, 7:129. 1881. Spores too small (15 μ long) for *Protomyces*. Specimens not seen.

Protomyces menyanthis De Bary, Brandpilze 19. 1891. = *Cladochytrium menyanthis* De Bary on host *Menyanthis trifoliata* L. = *Doassansia comari* De Toni on host *Comarium palustre* L.

Protomyces microsporus Unger, Die Exantheme der Pflanzen Wein 343. 1833. = *Entyloma microsporus* (Unger) Schroter on host *Ranunculus repens* L. = *Entyloma ranunculi* (Bonorden) Schroter on host *Ficaria verna*. Specimens on *Ficaria* sp. examined.

Protomyces muscorum Karsten, Fragmenta Mycologia 11:4. 1884. The gelatinous nature of the spores and its association with mosses indicates that it might be a species of *Endogone*.

Protomyces najadis Chwodhury, Sydowia 23:46. 1869. Spores are large (100-192 x 79-144 μ), not resembling those of Protomycetaceae; the host belongs to the family Najadaceae. Specimens not seen.

Protomyces paridis Unger, Die Exantheme der Pflanzen 344. 1833. = *Sorosporium paridis* Unger. = *Tubercinia paridis* (Ung.) Vestergren on host *Paris quadrifolia* L.

Protomyces? persicifilus Spegazzini, Rev. Ministerio Agric. Buenos Aires 2(2):39. 1908. Symptoms do not resemble those of Protomycetaceae, and the host is a species of Rosaceae. Specimens not seen.

Protomyces physalidis Kalchenbrenner & Cooke, Grevillea 10:22. 1880. = *Entyloma australe* Spegazzini.

Protomyces? pithiophilus Karsten, Fragmenta Mycologica 11:4. 1884. Symptoms do not resemble those of Protomycetaceae, spores are of two different sizes, and the host is a species of Pinaceae. Specimens not seen.

Protomyces polysporus Peck. Name apparently not published. Source--Exsiccati de Thumen, Mycotheca Universalis 1813. *Protomyces polysporus* Nov. Spe. Leg. H. C. Peck. 1880. Spores are too small (9 μ) for *Protomyces*.

Protomyces punctiformis Niessl, Verhandlunger Naturf. Ver Brunn 10:166. 1872. = *Setchellia (Doassansia) punctiformis* Magnus.

Protomyces purpureo-tinges Massee, British Fungi 164. 1891. Symptoms do not resemble those of Protomycetaceae and the host is a species of Liliaceae.

Protomyces radicicola Zopf, Handbuch der Botanik von Professor Dr. A. Schenk 4:280. 1890. Infection occurs in the roots of a species of Scrophulariaceae. Both the location of infection site and the host family are not characteristic of Protomycetaceae. Specimens not seen.

Protomyces reticulatus Saccardo, Michelia I:13. 1879. Formation of "endospores" (one per sporangium) and symptoms differ from those of Protomycetaceae. Specimens not seen.

Protomyces rhizobius Trail, Scottish Naturalist and Journal of Perthshire Society of Natural Sciences 125. 1884. Infection occurs in the roots of *Poa*. Both the location of infection site and the host are not characteristic of Protomycetaceae. Specimens not seen.

Protomyces sagittariae Fuckel, Symb. Mycol. 75. 1869. = *Doassansia sagittariae* (West.) Fischer.

Protomyces stellariae Fuckel, Enumeration Fungorum Nassoviae series 1:1. 1860. = *Peronospora alsineriarum* Casp.

Protomyces theae Zimmerman, Centrablatt f. Bakteriologie 2(4):140. 1901. Infection occurs on the roots of a species of Theaceae. Both the location of infection site and the host family are not characteristic of Protomycetaceae. Specimens not seen.

Protomyces tuberum-solani Martinus, Die Kartoffel Epidemie der letzen Jahre oder die Stocksaule und Raude der Kartoffeln. Muchen 28. 1842. = *Spongospora scabies* (Berkeley) Massee.

Protomyces vagabundus Spegazzini, Revista Argentina de Historia Natural 37. 1891. = *Urophlyctis hemisphaerica* (Speg.) Sydow.

Protomyces violaceus Cesati. Atti della 6. Ruionne degli Scienziati Italinao 511. Milano. 1884. = *Ustilago haesendonckii* West.

Protomyces xylogenus Saccardo, Michelia I:14. 1879. = *Sphaerosporium lignatile* Schweinitz. = *Coccospora aurantiaca* Wallr. on host "*Populus anonymae*".

GENUS PROTOMYCOPSIS

Protomycopsis Magnus, Die Pilze (Fungi) von Tirol, Vorarlberg und Liechtenstein 322. 1905.

Members parasitic on species of Compositae, producing swellings and slightly raised spots on the leaves. Ascogenous cells, formed terminally on the mycelium, occurring throughout the infected tissues of the host; spherical to subspherical, light yellowish-brown; rough-walled at least when young; germinating after a period of rest, producing a vesicle within which numerous ascospores are formed.

Fusion of ascospores reported.

TYPE: *Protomycopsis leucanthemi* Magnus

KEY TO SPECIES OF PROTOMYCOPSIS BASED ON HOST GENERA

Bellis

Ascogenous cells 32(26-41) μ, wall rugulose; leaf spots barely raised . . . .*P. bellidis*

Chrysanthemum

Ascogenous cells 35(22-48) μ, wall rugulose; leaf spots barely raised . . . . *P. leucanthemi*

Hyoseris

Ascogenous cells 30(22-48) μ, smooth walled when mature; blisters on leaves, small and round . . . . *P. hyoseridis*

Leontodon

Ascogenous cells 34(30-41) μ, smooth walled when mature. Small galls on midrib and veins . . . . *P. leontodontis*

1. *Protomycopsis arnoldii* Magnus, Pilzflora von Tirol 322. 1915.

HOST: *Leontodon montani* Lam.

DISTRIBUTION: Europe

OBSERVATIONS: By its host genus, symptoms, and ascogenous spore measurements (as reported by von Buren, 1922), this species appears to be very similar to *Protomycopsis leontodontis*. It is possible they are synonymous. However, specimens of *P. arnoldii* were not available for study.

2. *Protomycopsis belledis* (Krieger) Magnus in G. von Buren, Beitr. Kryptfl. Schweiz 5(1):85. 1915.

SYNONYM: *Protomyces belledis* Krieger, Hedwigia 35:144.

1896.

ILLUSTRATIONS: Figs. 53-56.

Round, yellowish to yellow-brown, barely raised leaf spots. Ascogenous cells 32(26-41) μ, spherical to subspherical, immature cells often elliptical.

HOST GENUS: *Bellis*

DISTRIBUTION: Europe: E. and W. Germany, Switzerland.

3. *Protomycopsis hyoseridis* Sydow, Ann. Mycol. 12:197. 1914.

ILLUSTRATIONS: Figs. 57-60.

Small, round, pale yellow blisters on leaves. Ascogenous cells 30(22-37) μ spherical to subspherical; light yellowish-brown to light brown. Spore germination not observed.

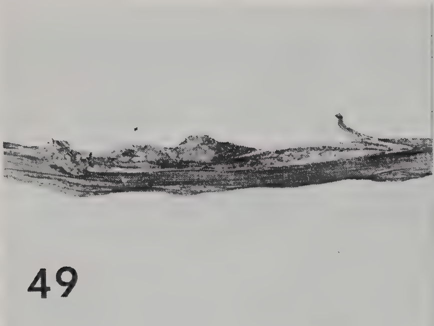
HOST GENUS: *Hyoseris*

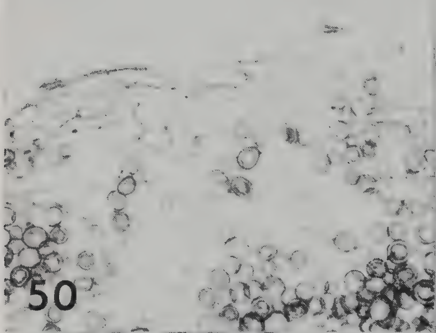
DISTRIBUTION: Europe: Italy, France.

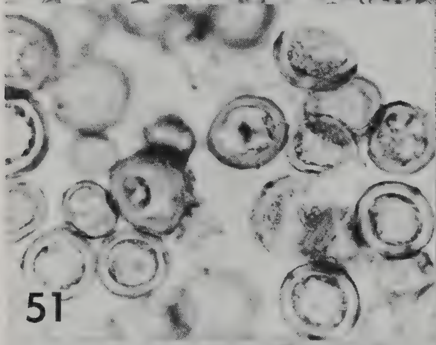
4. *Protomycopsis leontodontis* von Buren, Beitr. Kryptfl. Schweiz 5(3):71. 1922.

Figs. 49-52. *Protomyces sonchi*: 49, galls on stems of *Sonchus arvensis*; 50-51, cross section of gall (50, 73X; 51, 284X); 52, teased ascogenous cells, 284X. Figs. 53-56. *Protomycopsis belledis*: 53, spots on leaves of *Bellis perennis* (arrows); 54-55, cross section through leaf spot (54, 73X; 55, 284X); 56, teased ascogenous cells showing rugulose wall (arrow), 284X.

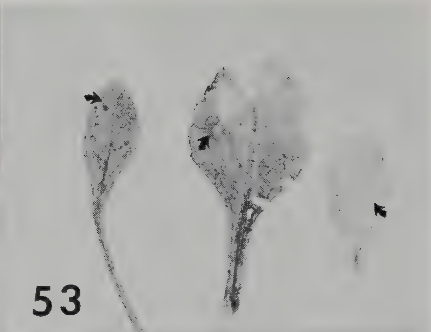
Figs. 57-60. *Protomycopsis hyoseridis:* 57, blisters on leaves of *Hyoseris baetica* (arrow); 58-59, cross section through the blister (58, 73X; 59, 284X); 60, teased ascogenous cells, 359X. Figs. 61-64. *Protomycopsis leontodontis*: 61, galls on the mid-ribs of *Leontodon autumnale* (arrows); 62-63, cross section through the gall (62, 73X; 63, 284X); 64, teased ascogenous cells, 284X.

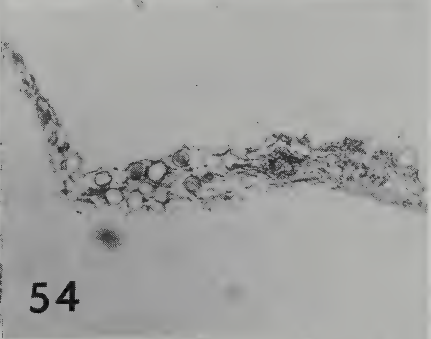

49

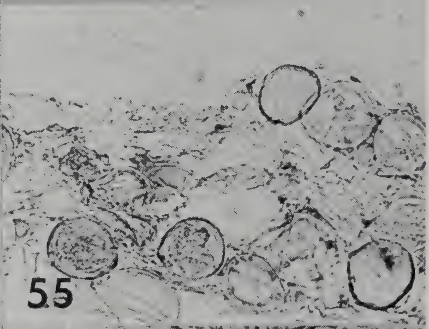

50

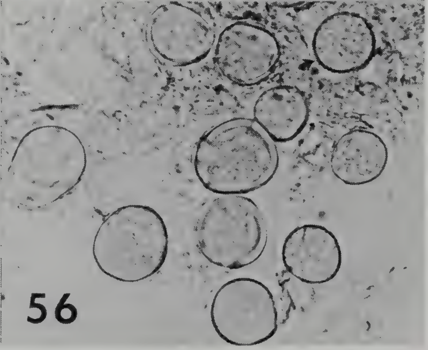

51

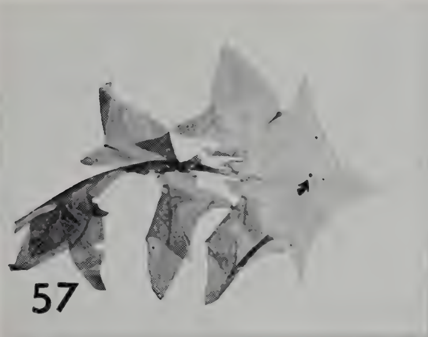
52

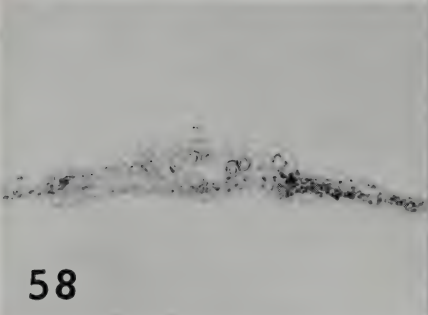

53


54


55


56

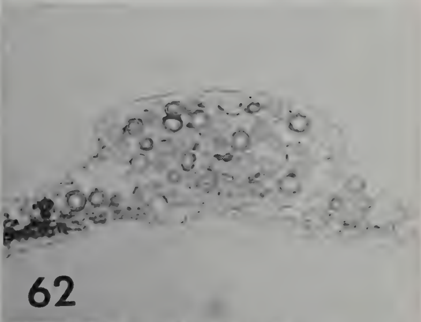

57

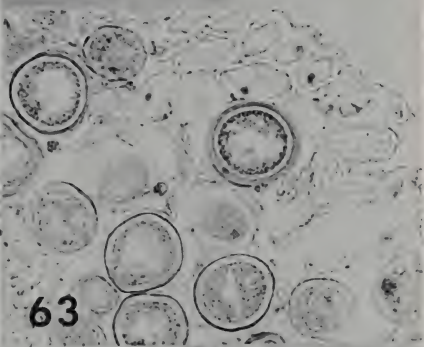

58

59

60

61


62


63

64

ILLUSTRATIONS: Figs. 61-64.

Small galls on midrib and veins. Ascogenous cells 34 (30-41) µ, spherical, rugulose when young and smooth walled when mature; vesicle 105 x 45 µ.

HOST GENUS: *Leontodon*

DISTRIBUTION: Europe: Finland, Sweden.

OBSERVATIONS: Based on the host genus, symptoms, and ascogenous cell measurements (as reported by von Buren, 1922), this species appears to be very similar to *Protomycopsis arnoldii*. It is possible they are synonymous. However, specimens of *P. arnoldii* were not available for study.

5. *Protomycopsis leucanthemi* Magnus, Die Pilze von Tirol, Vorarlberg und Liechtenstein 323. 1905.

ILLUSTRATIONS: Figs. 65-69.

Greyish-yellow, slightly raised leaf spots. Ascogenous cells 35(22-48) µ, spherical to subspherical, rugulose; vesicle 52-66 µ long and 37-48 µ broad. Ascospores 4 x 2.5 µ.

HOST GENERA: *Chrysanthemum* and *Achillea*

DISTRIBUTION: Europe: Austria, E. and W. Germany, Switzerland.

OBSERVATIONS: *Protomycopsis chrysanthemi* von Buren (Beitr. Kryptfl. Schweiz 5(3):76. 1922; *Chrysanthemum atratum* L. and *C. alpinum* L.) seems to be very close to *Protomycopsis leucanthemi* because of the similarities in host genus, symptoms, and ascogenous cell measurements. Possibly the species are synonymous. However, this cannot be said with certainty as no specimens of *Protomycopsis chrysanthemi* were available for comparative study.

SPECIES UNAVAILABLE FOR STUDY

Species listed here have been reported as belonging to the genus *Protomycopsis*. Although apparently their ascogenous cells have never been germinated and specimens have not been available for study, they quite likely should be included as recognized species.

Protomycopsis pharenris Jaap, Ann. Mycol. 19:4. 1916.

HOST: *Pallenis spinosa* (L.) Cass.

DISTRIBUTION: Asia Minor: Turkey

Protomycopsis pullicariae Maire, Bulletin de la Societe Historie Naturelle Afrique de Nord 22. 1931.

HOST: *Pulicaria inuloides* DC.

DISTRIBUTION: N. Africa: Algeria

DOUBTFUL SPECIES OF PROTOMYCOPSIS

Protomycopsis ajmeriensis Gupta, Indian Phytopathology 9:72. 1956. (See comments at end of this section)

Protomycopsis crotolariae Joshi, Current Science 24: 168. 1955. (See comments below.)

Protomycopsis phaseoli (Patel, Kulkarni & Dhande) Ramakrishan & Subramanian, The Madras University Journal B. 26(2):367. 1956. (See comments below.)

SYNONYMS: *Synchytrium phaseoli* Patel, Kulkarni & Dhande RS46. This name has probably never been published.
Protomycopsis patelli Pavgi & Thirumalachar, Nature 172:315. 1953.

Protomycopsis thirumalacharii Pavgi, Experientia 25 (5):282. 1965.

The above four species are parasitic on Leguminosae, a family that is not host to any other recognized species of Protomycetaceae. We examined specimens of the species and observed that their spores were much smaller, darker, and more heavily ornamented than those of Protomycetaceae, and they appeared to be produced both terminally and intercalaraly on the mycelium. Haware and Pavgi (1971), who germinated the spores of *P. patelii* and *P. thirumalacharii*, did not observe ascospore production within a vesicle, indicating a different mode of germination than that seen in

Protomycetaceae. Moreover, both species produced mycelium in culture, in contrast to the yeastlike growth produced by species of Protomycetaceae. In addition, one of them, *P. thirumalacharii*, was reported to have a conidial stage (Pavgi and Haware, 1970). These characters do not indicate a relationship to the Protomycetaceae.

GENUS TAPHRIDIUM

Taphridium Lagerheim & Juel, Bihang Till K. Svenska Vet-Acad. Hardlinger 27(3):7. 1902.

Members parasitic on species of Umbelliferae, causing effused blotches on leaves. Ascogenous cells occurring in a single, compact, continuous layer beneath the epidermis; spherical, elliptical to polyhedral, because of mutual pressures; almost hyaline, smooth walled; germinating immediately without a rest period; vesicles not produced. Ascospores produced within the ascogenous cell (without the formation of a vesicle), released by the rupture of the ascogenous cell wall; following their release, ascospores fusing in pairs.

TYPE SPECIES: *Taphridium umbelliferarum* (Rostrup) Lagerheim & Juel.

KEY TO THE SPECIES OF TAPHRIDIUM

1. Ascogenous cells 55(30-78) μ, parasitic on *Carum* and *Furula*. *T. algeriense*
1. Ascogenous cells 35(19-48) μ, parasitic on species of *Angelica*, *Heracleum* and *Peucedanum*. . *T. umbelliferarum*

1. *Taphridium algeriense* Juel, Bihang Till K. Svenska Vet-Acad. Hardlinger 27(3):7. 1902.

ILLUSTRATIONS: Figs. 70-72.

Effused blotches on upper surface of leaves. Ascogenous cells 55(30-78) μ, smooth walled, spherical, elliptical to polyhedral because of mutual pressure; hyaline. Ascospores 4 x 2 μ.

HOST GENERA: *Carum* and *Ferula*

DISTRIBUTION: N. Africa; Algeria; Europe: Finland, U.S.S.R.

2. *Taphridium umbelliferarum* (Rostrup) Lagerheim & Juel, Bihang Till K. Svenska Vet-Acad. Hardlinger 27(3):7. 1902.

SYNONYMS: *Taphrina umbelliferarum* Rostrup, Botan. Tidsskrift, Kjobenhavn 14:239. 1883.
Taphrina oreoselini Massalongo, Nuovo Giornale Botanico Italiano 21:141. 1889.
Magnusiella umbelliferarum Sadebeck, Jahrb. Hamburg, wiss, Anstalt 10(2):88. 1893.
Volkartia umbelliferarum (Rost.) von Buren, Beitr. Kryptfl. Schweiz 5(1):69. 1915.

ILLUSTRATIONS: Figs. 73-75.

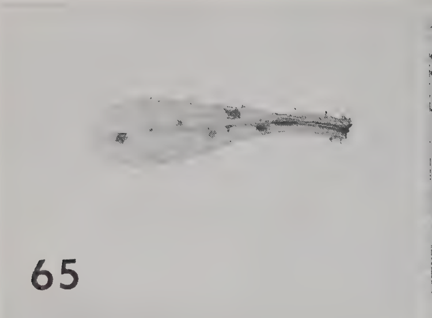
Effused blotches, often extensive, on the upper surface of the leaves. Ascogenous cells 35(19-48) μ, spherical, elliptical to polyhedral because of mutual pressure; hyaline, smooth walled. Ascospores 2-7 x 1-4 μ.

HOST GENERA: *Angelica, Heracleum, Peucadanum*

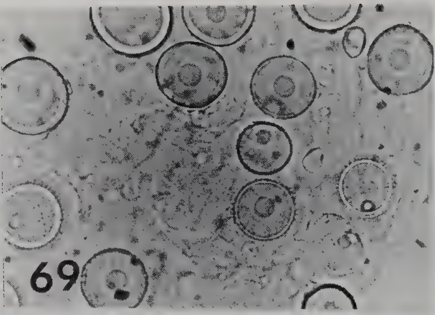
DISTRIBUTION: Asia: Japan; N. America: California; Europe: Austria, Czechoslovakia, Denmark, England, Finland, E. and W. Germany, Ireland, Italy, Norway, Scotland, Sweden, Switzerland, U.S.S.R.

Taphridium umbelliferarum has been reported to occur on *Heracleum aspercum* Bieb. but specimens were unavailable for study.

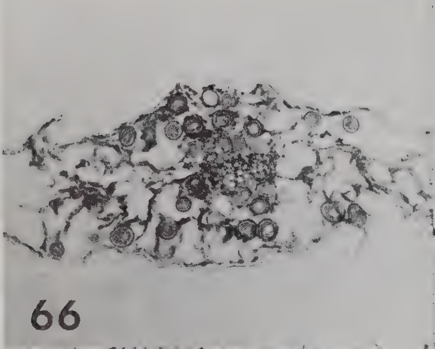
Figs. 65-69. *Protomycopsis leuconthemi*: 65, spots on leaves of *Chrysanthemum leucanthemi*; 66-67, cross section through the leaf spot (66, 73X; 67, 284X); 68, teased ascogenous cells showing rugulose wall (arrow), 284X; 69, young ascogenous cells, 284X. Figs. 70-72. *Taphridium algeriense*: 70, effused leaf blotches on leaves of *Ferula communis* (arrows); 71, cross section of leaf blotch, ascospores (arrow) produced within ascogenous cells, 284X; 72, teased ascogenous cells, 284X.



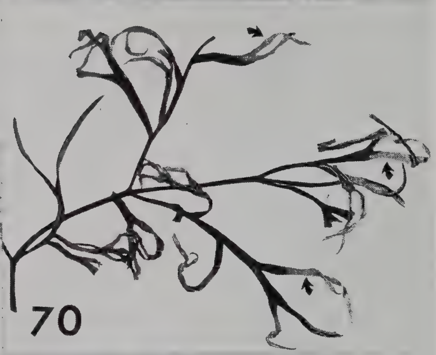
65



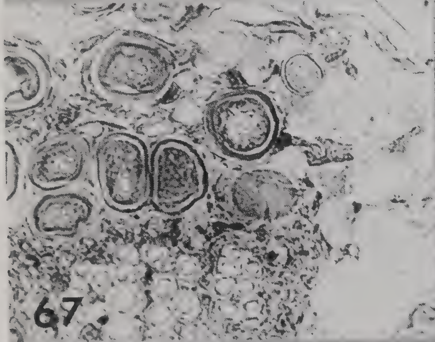
69



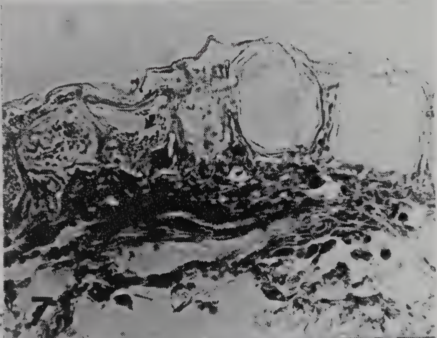
66



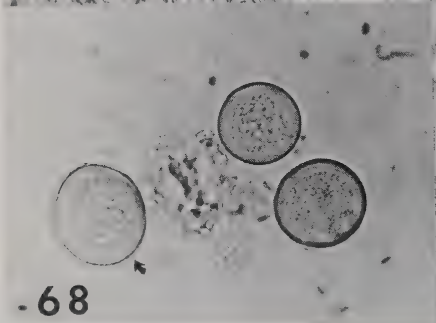
70



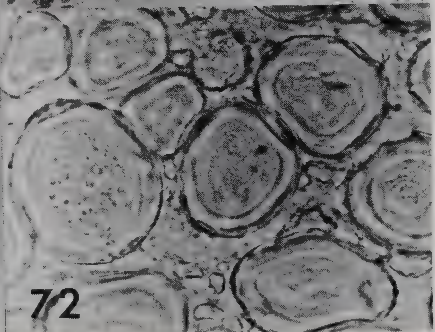
67



71



68



72

GENUS VOLKARTIA

Volkartia Maire, Bull. de la Societe Botanique de France 54:145. 1907.

Parasitic on species of Compositae. Ascogenous cells in a single compact continuous layer, usually beneath the upper epidermis; spherical, smooth walled; germinating immediately by producing a vesicle. Ascospores produced either in the ascogenous cell, then moving into the vesicle, or produced in the vesicle; ascospores fusing in pairs following their release.

The single species *Volkartia rhaetica* is recognized.

TYPE SPECIES: *Volkartia rhaetica* (Volkart) Maire

The fungus originally described as *Taphrina rhaetica* by Volkart (1903) also has been referred to as *Taphridium crepidis* (Lagerheim, 1903). Maire (1907) erected the genus *Volkartia* to accommodate this organism, distinguished from *Taphrina* and from *Taphridium* by its thick-walled ascogenous cells that germinate by producing a vesicle. Von Buren (1915, 1922) considered *Taphridium* and *Volkartia* to be synonymous, based on the ascogenous cells that occurred in a single subepidermal layer. We have chosen to retain *Volkartia* separate from *Taphridium*.

1. *Volkartia rhaetica* (Volkart) Maire, Bull. de la Societe Botanique de France 45:146. 1907.

SYNONYMS: *Taphrina rhaetica* Volkart, Berichte der Duetschen Botan. Gesellschaft. 21:477. 1903. *Taphridium crepidis* Lagerheim in Vestergren, Micromycetes rariores selecti 719--Exsiccati (15.6. 1903).

ILLUSTRATIONS: Figs. 76-79.

Produces blotches, occasionally puckering the leaves. Ascogenous cells spherical, 17(11-22) μ, hyaline; vesicle oval, oblong to cylindrical, 60-120 x 15-25 μ. Ascospores 4-7 x 1-2 μ.

HOST GENUS: *Crepis*

DISTRIBUTION: Europe: France, E. and W. Germany, Switzerland.

PHYLOGENETIC RELATIONSHIPS

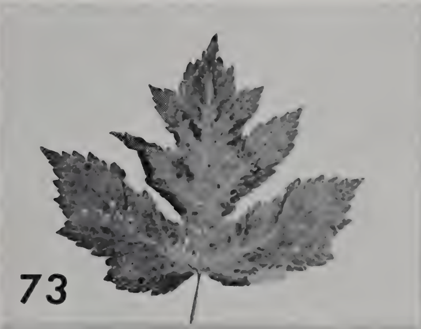
Recent workers, including Tubaki (1957), Valadon *et al.* (1962), Pavgi and Mukhopadhyay (1970), and Kramer (1973), place the Protomycetales in the Hemiascomycetes. In the past Protomycetales were included in the Ascomycetes, based primarily on the assumption that the vesicle within which the ascospores are produced was a synascus containing numerous naked asci. Now that meiotic division of the diploid nuclei within the vesicle, resulting in tetrads of haploid spores (Pavgi and Mukhopadhyay, 1970), has been demonstrated, there remains little doubt that these fungi should be placed among the Ascomycetes.

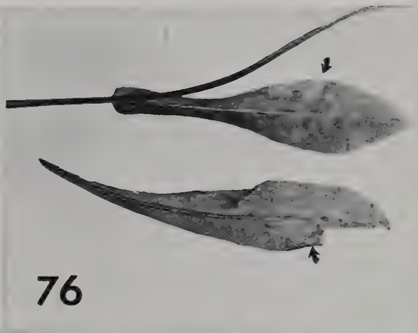
Based on their cell-wall composition and their predominantly diploid life cycle Valadon *et al.* (1962) considered the Protomycetaceae as a family in the Endomycetales. They considered *Protomyces* as derived from *Spermophthora* (Spermophthoraceae) or its ancestral forms. Tubaki (1957) considered *Protomyces* to be related to *Taphrina*, because the two species are similar in nutritional physiology, cultural characters, and parasitic mycelial stage (in contrast to the yeastlike growth in culture). However, he added that *Protomyces*, also related to yeasts in cultural characters, must have evolved from the yeasts, possibly the Endomycetaceae or Cryptococcaceae. On the basis of GC (gaunine-cytocine) content of 52-52.4% in three species of *Protomyces*, Nakase and Komagata (1971) indicated a close relationship between *Protomyces* and *Taphrina*. Apparently, also a strong relationship exists between yeasts and the Protomycetales, and Protomycetales and Taphrinales.

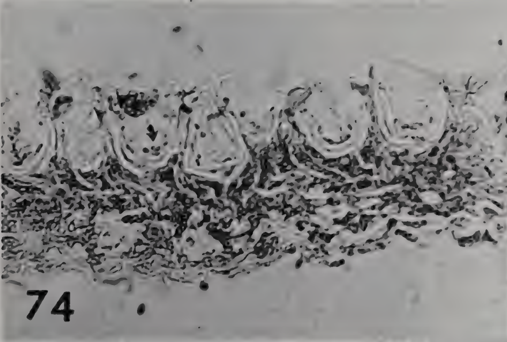
Protomyces probably evolved from yeasts through members of the Spermophthoraceae, Endomycetaceae, or Cryptococcaceae. However, Pavgi and Mukhopadhyay (1970) have indicated the possibility of a monophyletic origin of

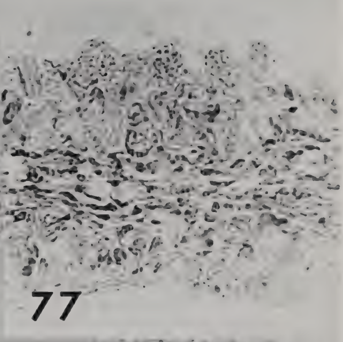
---

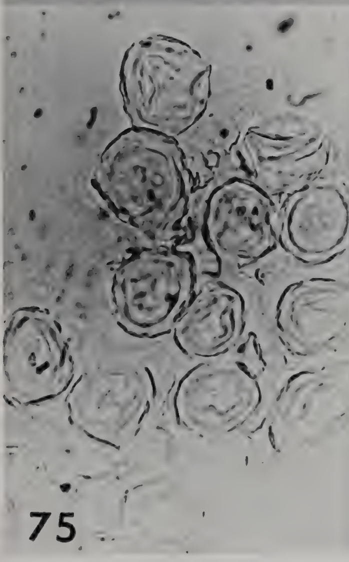
Figs. 73-75. *Taphridium umbelliferarum*: 73, effused blotch on leaf of *Heraclum sibiricum*; 74, cross section of leaf blotch, ascospores (arrow) produced within ascogenous cells, 284X; 75, teased ascogenous cells, 284X. Figs. 76-79. *Volkartia rhaetica*: 76, blotches on leaves of *Crepis succisaefolia* (arrows); 77, cross section of leaf blotch, ascogenous cells and vesicles with ascospores, on both upper and lower surfaces, 284X; 78, teased ascogenous cell (a), germinating ascogenous cell (b) and vesicle (c) with endospores, 284X; 79, germinating ascogenous cells.

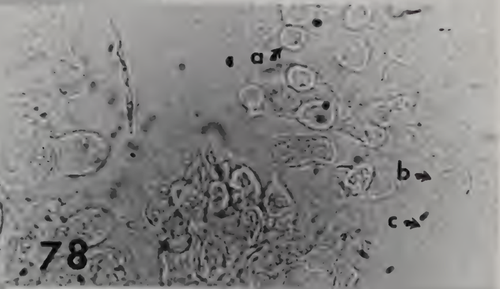

73

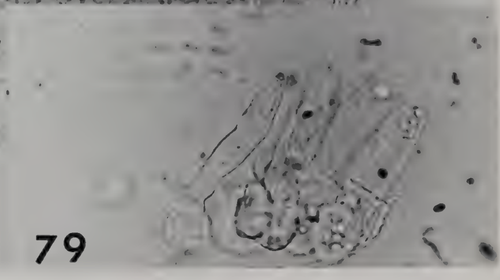

76


74


77


75

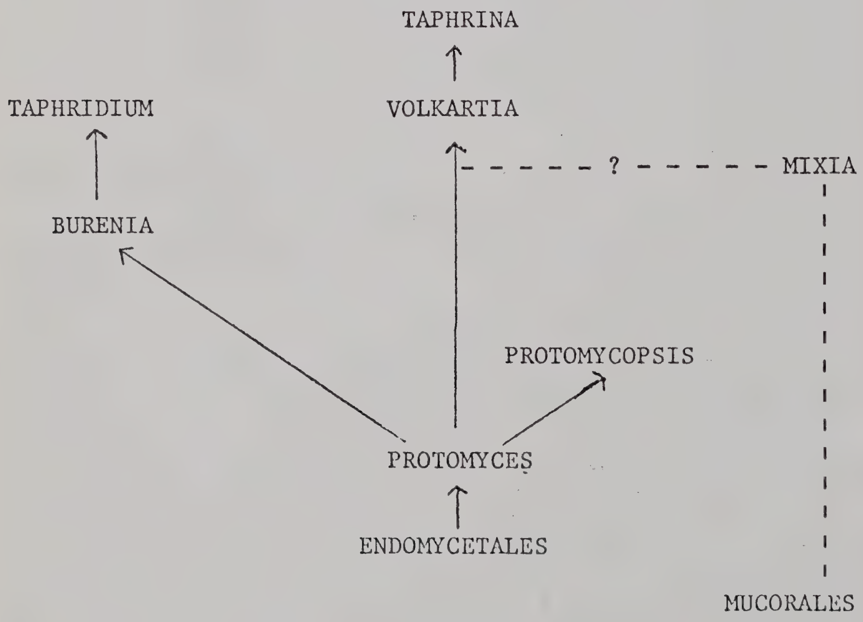

78


79

Ascomycetes (*Protomyces*) from Phycomycetes through members of the Entomophthorales, such as species of *Basidiobolus* that produce endospores in tetrads.

The genus *Mixia* tentatively was placed in the Protomycetales (Kramer, 1958, 1973), because of enlarged multinucleate cells that develop from the mycelium and give rise to vesicles within which "endospores" are produced. The single species of the genus, *Mixia osmundae* (Nishida) Kramer, has not been studied cytologically, and thus it is not known if meiosis occurs in the vesicle prior to "endospore" formation. If it does, it may be proper to treat the genus as a separate family within the Protomycetales. However, the formation of a columella within the vesicle from the basal cells and the fern hosts do not indicate a close relationship with the genera treated in this study.

The possible phylogenetic relationships of the genera of this group and of other related groups is shown in this diagram:



The genera *Protomyces* and *Protomycopsis* have much in common; they differ mainly in the position of their ascogenous cells on the mycelium. Quite likely, species of *Protomycopsis* have arisen from members of *Protomyces*. *Protomyces inouyei* produces ascogenous cells intercalaraly on the mycelium (as does any other species of *Protomyces*), but the ascogenous cell walls are rough like those of *Protomycopsis*.

The genus *Burenia* has been created to accommodate two species that resemble both *Protomyces* and *Taphridium*. The ascogenous cells in *Burenia* germinate immediately without producing a vesicle. Von Buren's (1918) observation that occasionally a few of the ascogenous cells of *Burenia inundata* germinate to produce a vesicle after a rest period indicates its relationship to *Protomyces*. In *Burenia cicuta*, all the ascogenous cells germinate immediately, as in the genus *Taphridium*, without forming a vesicle. *Taphridium* differs from *Burenia cicuta* in the location of its ascogenous cells--in a single subepidermal layer. The ascogenous cell walls of *Taphridium* and *Burenia* (best seen in germinated cells) are comparatively thinner than those of *Protomyces*.

Although von Buren (1915) and Juel (1921) have considered them synonymous, *Volkartia* and *Taphridium* have been retained here as separate genera, based on the production of a vesicle by the former and its absence in the latter. *Volkartia* differs from *Protomyces* in that it produces ascogenous cells in a single subepidermal layer and in that they germinate immediately. The single layer of germinated ascogenous cells (the smallest of any member of the Protomycetales) plus vesicles filled with ascospores superficially resembly species of *Taphrina*. Also, the symptoms, leaf spots, and blisters, are similar to those of many species of *Taphrina*.

BIBLIOGRAPHY

De Bary, A. 1887. Comparative Morphology and Biology of Fungi, Mycetozoa and Bacteria. Clarendon Press, Oxford. 525 p.

Bessey, E. A. 1950. Morphology and taxonomy of fungi. The Blakiston Co., Philadelphia. 791 p.

Brefeld, O. and F. von Tavel. 1891. Untersuchungen aus dem Gesamtgebiete der Mycologie. IX Heft. Die Hemiasci und Ascomyceten 91-118.

Büren, G. von. 1915. Die schweizerischen Protomycetaceen mit besonderer Berücksichtigung ihrer Entwicklungsgeschichte und Biologie. Beitr. Kryptfl. Schweiz 5(1): 1-95.

_____. 1918. Beitrag zur Biologie und Entwicklungsgeschichte von *Protomyces inundatus* Dang., Mitt. noturf. Ges. Bern 109-132.

_____. 1922. Weitre Untersuchungen uber die Entwicklungsgeschichte und Biologie der Protomycetaceen. Beitr. Kryptfl. Schweiz 5(3):1-94.

Dangeard, P. A. 1906. Les ancestres des champignons superieus. Le Botaniste 9:263-303.

Davis, J. J. 1907. A new species of Protomyces. Jour. of Mycol. 13:188-189.

Fitzpatrick, H. M. 1930. The lower fungi--Phycomycetes. McGraw-Hill Book Co., Inc., New York. 331 p.

Gäumann, E. 1964. Die Pilze. Birkhauser Verlag, Basel und Stuttgart. 541 p.

_____ and C. W. Dodge. 1928. Comparative morphology of fungi. McGraw-Hill Book Co., New York. 701 p.

Gupta, J. S. and S. Sinha. 1964. Variations in pathogenicity of *Protomyces macrosporus*. Ung. Proc. Nat. Acad. Sci. India. 34:241-244.

Haware, M. P. and M. S. Pavgi. 1971. Perpetuation of *Protomycopsis* species causing purple leaf spot of legumes in India. Ann. Phytopathol. Soc. Jap. 37(4): 242-248.

Juel, H. O. 1902. *Taphridium* Lagerh. et. Juel. Eine neue gattung der Protomycetaceen. Bihang Till K. Vet-Acad. Handlinger 27:1-29.

_____. 1921. Cytologische Pilzstudien II. Zur Kenntnis Einiger Hemiasceen. Nova Acta Regiae Societatis Scientiarum Upsaliensis 5:1-41.

Kramer, C. L. 1958. A new genus in the Protomycetaceae. Mycologia 50:916-926.

_____. 1973. Protomycetales and Taphrinales. The Fungi (vol. 4). Academic Press, London and New York. 33-41 pp.

Lagerheim, G. von. 1903. Vestergren, Micromycetes rariores selecti. 719. *Taphridium crepidis* n. sp. 15.6 1903. Exsiccati.

Lindroth, J. J. 1904. Uber eine neue *Taphridium*-Art. Acta Societatis pro Fauna et Flora Fennica 26(5):5-9.

Magnus, P. 1896. Verhandl. Zool. Bot. Ges. Wien. 46:248.

Maire, R. 1907. Contribution a l'etude de la flore mycologique des Pyrenees-Champignons recoltes a la session de la Societe botanique de France a Gavernie et Cauterets en 1907. Bull. Soc. Bot. France 55:144-165.

Martin, G. W. 1950. Outlines of the Fungi. William C. Brown, Dubuque, Iowa. 82 p.

Nakase, T. and K. Komagata. 1971. DNA base composition of some species of yeasts and yeast-like fungi. J. Gen. Appl. Microbiol. 17(5):363-369.

Nozu, M. and M. Yamamoto. 1970. Electron Microscopy of *Protomyces inouyei* P. Henn. causing hypertrophy of *Crepis japonica* Benth. Trans. Mycol. Soc. Jap. 11(2): 76-80.

Pavgi, M. S. and M. P. Haware. 1970. Conidial discharge in *Protomycopsis thirumalacharii*. Pathol. Microbiol. 35(5):297-302.

_____, and A. N. Mukhopadhyay. 1970. Cytology of chlamydospore germination in *Protomyces macrosporus* Unger. Cytologia (Tokyo) 35(3):359-367.

Phillips, W. 1883. Herbarium William Phillips. *Protomyces helosciadii* n. sp. Summer 1883. Exsiccati.

Plowright, C. B. 1889. A monograph of the British Uredinae and Ustilaginae. Kegan, Paul, Trench etc. Co., London. 347 p.

Popta, C. M. L. 1899. Beitrag zur Kenntnis der Hemiasci. Flora 86:1-46.

Sappin-Trouffy, P. 1897. Note sur la place da *Protomyces macrosporus* Unger dans la classification. Le Botaniste 5:285-288.

Sawada, K. 1922. Descriptive Catalogue of the Formosan Fungi 3:53.

______. 1928. Descriptive Catalogue of the Formosan Fungi 4(33):123 p.

Tubaki, K. 1957. Biological and cultural studies of three species of *Protomyces*. Mycologia 49:44-54.

Unger, F. 1833. Die Exantheme der Pflanzen. Wien 12: 422 p.

Valadon, L. R. G., J. G. Manners and A. Myers. 1962. Studies on the Life-History and Taxonomic Position of *Protomyces inundatus* Dangeard. Trans. Brit. Mycol. Soc. 45(4):573-586.

Venitt, S., A. Myers and J. G. Manners. 1968. Studies of conjugation in *Protomyces inundatus*. Exptl. Cell Res. 50:9-18.

Volkart, A. 1903. *Taphrina rhaetica* nov. spec. und *Mycosphaerella aronici* (Fuckl.). Ber. Deutsch. Bot. Ges. 21:477-481.

Ward, H. M. 1887. On the structure and life history of *Entyloma ranunculi*. Phil. Transact. Roy. Soc., London. 178:10-13.

MYCOTAXON

Vol. III, No. 1, pp. 51-54 October-December 1975

A NEW SPECIES OF SYNCEPHALASTRUM

P. C. MISRA

Department of Botany, University of Gorakhpur
Gorakhpur 273001, U.P., India

SUMMARY

Syncephalastrum verruculosum Misra, a new species isolated from air of Gorakhpur, India, is described and illustrated.

The genus *Syncephalastrum* Schroeter is characterized by cylindrical, multispored merosporangia borne in large numbers on the surface of vesicular enlargements produced terminally on simple or branched sporangiophores; the zygospores are *Mucor*-like in formation and appearance. Benjamin (1959, 1966), and Hesseltine and Ellis (1973) recognize a single species, *S. racemosum* Cohn ex Schroeter, in this genus.

An interesting species of *Syncephalastrum* was isolated by the author in February 1973. It appeared in a petri dish containing Martin's peptone-dextrose agar medium (Martin, 1950) and exposed to air in a first-floor verandah of the Department of Botany, University of Gorakhpur. The fungus grew readily in pure culture and is believed to be sufficiently different from *S. racemosum* to be regarded as a new species on morphological grounds. The isolate is described here as a new species. The description is based on monospore cultures grown on synthetic *Mucor* agar (SMA; Hesseltine, 1954) and potato dextrose agar (PDA) media. The color plate numbers in parentheses are cited from Maerz and Paul (1950). The specific epithet of the new taxon is based on the verruculose nature of its sporangiospores.

SYNCEPHALASTRUM VERRUCULOSUM sp. nov. (Fig. 1)

Coloniae in SMA (agaro composito ad Mucoraceas colendas idoneo) vel PDA (agaro e Solani tuberis cum dextroso composito) septem dies ad 25 C caloris vigentes 9 cm diametro, viridi-griseae, denique pallide brunneae, c. 1 mm altae, vel-

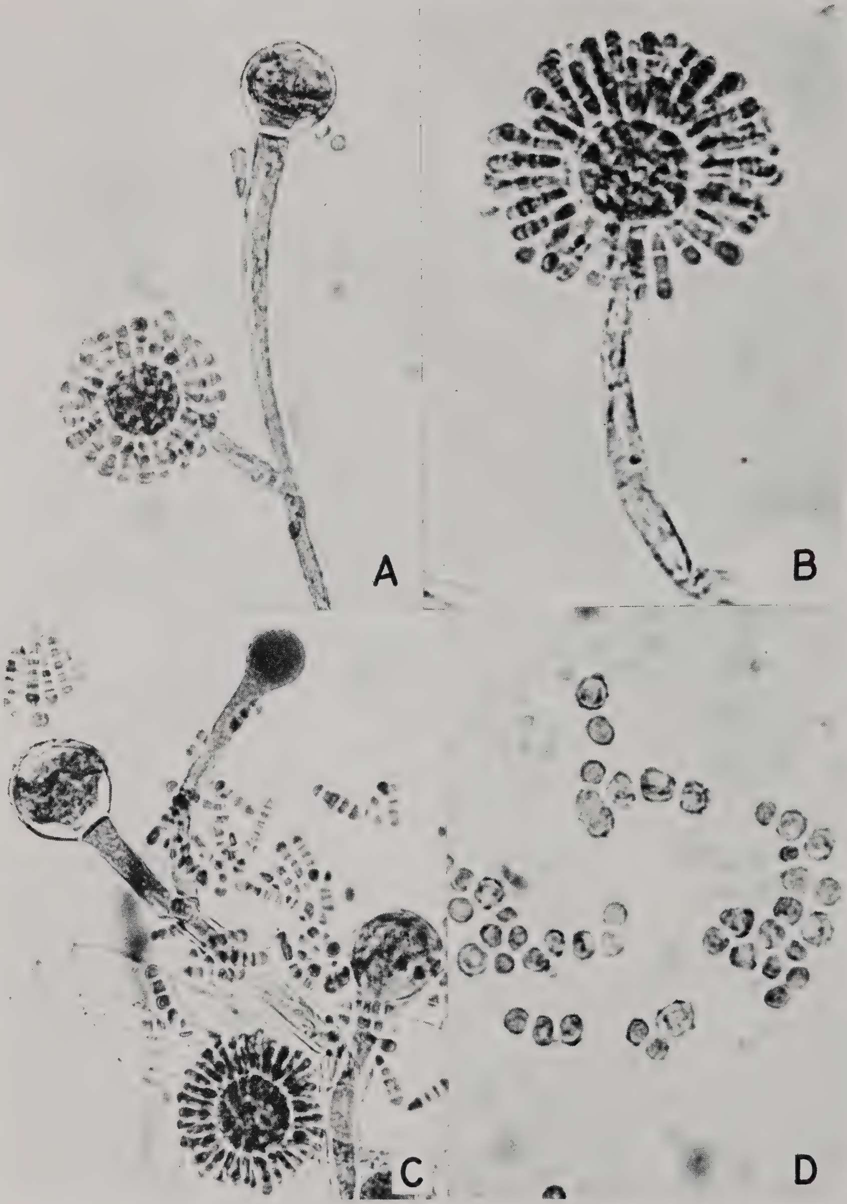


Fig. 1. *Syncephalastrum verruculosum*. A-C, sporangiophores and merosporangia (A x450; B x700; C x400). D, sporangiospores (x750). All stained with cotton blue.

utinae. Hyphae vegetabiles submersae, hyalinae, abunde ramosae, 3.5 - 10.5 μ crassae, primo haud septatae, maturae irregulariter septatae. Sporangiophora directe e hyphis submersis orta, recta vel ascendentia, primo simplicia, denum cymose ramosa, irregulariter septata, hyalina vel paulum tincta; eorum axes primarii 7 - 13 μ crassi, vesiculas terminales 25 - 40 μ diametro gerentes; ramuli laterales 20 - 100 μ longi, 5.5 - 9.5 μ crassi, vesiculas terminales 14 - 28μ diametro gerentes. Vesiculae globosae, plerumque a septis subtentae, pallide brunneae. Merosporangia claviformia, prope medium paulum constricta, 13 - 23 μ longa, ad partem maximam 4 - 7 μ diametro, seriem unam sporangiosporarum (2-) 3 - 5 (-6) includentia, spora terminali maxima. Sporangiosporae globosae vel subglobosae, raro obovoideae vel oblongae, 4 - 7μ diametro, verruculosae, cumulo pallide brunneae. Zygosporae non visae.

Colonies on SMA or PDA 9 cm in diam in 7 days at 25 C, greenish grey (near plate 23 C1), later becoming light brown (near plate 16 E8), about 1 mm high, velvety. Vegetative hyphae submerged, hyaline, richly branched, 3.5 - 10.5 μ in diam, nonseptate at first, becoming irregularly septate in age. Sporangiophores arising directly from submerged hyphae, erect or ascending, at first simple, becoming cymosely branched, irregularly septate, hyaline or slightly pigmented. Primary axes of the sporangiophores 7 - 13 μ in diam, producing terminal vesicles 25 - 40 μ in diam, lateral branches of the sporangiophores straight or curved, 20 - 100 μ long, 5.5 - 9.5 μ in diam, producing terminal vesicles 14 - 28 μ in diam. Vesicles globose, usually subtended by simple septa, light brown, producing merosporangia over their entire surface and forming dark grey heads about 45 - 90 μ in diam. Merosporangia clavate, slightly constricted near the middle, 13 - 23 μ long, 4 - 7 μ in diam at the widest part, with evanescent walls, containing a single row of (2-)3-5(-6) sporangiospores, with terminal sporangiospore largest in size, rarely containing a second incomplete file of spores. Sporangiospores globose or subglobose, rarely obovoid or oblong, 4 - 7 μ in diam, verruculose, light brown in mass. Zygospores not seen.

TYPE: PCM 165, isolated from air, Gorakhpur, India, February, 1973. A subculture of the type has been deposited with the Rancho Santa Ana Botanic Garden, Claremont, California, as No. RSA 2127.

Syncephalastrum verruculosum also grows well on yeast extract - soluble starch agar (YpSs; Benjamin, 1959) and malt extract agar (Blakeslee, 1915) media. The morphological features of the fungus do not vary to any significant extent on these media. Growth is very slow on Czapek's agar medium.

Syncephalastrum verruculosum differs sharply from *S. racemosum* in having very low, velvety colonies, narrower sporangiophores, smaller and consistently globose vesicles, shorter but wider merosporangia, fewer sporangiospores in the merosporangia, and larger sporangiospores which are verruculose.

ACKNOWLEDGEMENTS

The author wishes to thank Dr. R. K. Benjamin for examining the fungus and giving many helpful suggestions, Prof. K. S. Bhargava for encouragement and facilities, and Dr. Donald P. Rogers for the Latin translation of the diagnosis.

LITERATURE CITED

Benjamin, R. K. 1959. The merosporangiferous Mucorales. Aliso *4*: 321 - 433.

Benjamin, R. K. 1966. The merosporangium. Mycologia *58*: 1-42.

Blakeslee, A. F. 1915. Lindner's roll tube method of separating cultures. Phytopathology *5*: 68 - 69.

Hesseltine, C. W. 1954. The section *Genevensis* of the genus *Mucor*. Mycologia *46*: 358 - 366.

Hesseltine, C. W. and J. J. Ellis. 1973. Mucorales. *In* Ainsworth, G. C., F. K. Sparrow and A. S. Sussman [eds.], The Fungi: An Advanced Treatise. Vol. IV B. Academic Press, New York & London.

Maerz, A. and M. R. Paul. 1950. A Dictionary of Color. 2nd ed. McGraw-Hill Book Co., Inc., New York.

Martin, J. P. 1950. Use of acid, rose bengal and streptomycin in the plate method for estimating soil fungi. Soil Sci. *69*: 215 - 232.

MYCOTAXON

Vol. III, No. 1, pp. 55-80 October-December 1975

SOIL MICROFUNGI OF CENTRAL AND SOUTHERN OHIO[1]

L. H. HUANG[2] AND J. A. SCHMITT

Department of Botany, The Ohio State University,
Columbus, Ohio 43210

SUMMARY

A survey was made of soil microfungi in subsurface soil samples collected in 22 localities from the non-agricultural, relatively undisturbed areas of central and southern Ohio. Fungi were isolated by the dilution plate method and from soil subjected to alcohol treatment, heat incubation, and hair-baiting. A total of 180 species and one variety in 84 genera were obtained, including 26 phycomycetes, 43 ascomycetes, and 112 deuteromycetes. Forty genera are reported from Ohio soils for the first time. The most prevalent genera in a decreasing order of frequency were *Penicillium*, *Trichoderma*, *Mortierella*, and *Talaromyces*. The dominant species were *Aspergillus fumigatus*, *Fusarium oxysporum*, *Geniculisporium serpens*, *Mortierella nana*, *Mucor hiemalis*, *Nodulisporium* sp., *Talaromyces luteus*, *T. trachyspermus*, *Trichoderma hamatum*, *T. koningii*, and *T. polysporum*. Six thermophilic fungi and 3 keratinophilic fungi were isolated. The alcohol treatment method appeared to be highly selective for the Ascomycetes, especially members of the Eurotiaceae, the Melanosporaceae, the Sordariaceae, and small discomycetes such as those of the Ascobolaceae and the Pyronemataceae. This method not only selected 36 ascomycetes, which accounted for about 84% of the ascomycete species, but

---

[1] Paper No. 891, Department of Botany, The Ohio State University, Columbus.

[2] Present address: Department of Plant Pathology, The University of Georgia, Athens, Ga. 30602

yielded many soil fungi which are infrequently recorded in the literature.

INTRODUCTION

Since Adametz (2) first isolated 11 filamentous fungi and four yeasts from the soil of some experimental plots in Germany, soil fungi have been studied for nearly 90 years. Some soil fungi are known to be potential allergens, zoopathogens, or phytopathogens, and others are capable of producing antibiotics, mycotoxins, and other metabolites. Moreover, soils provide a rich source of materials for taxonomic and morphological studies of fungi that sporulate in culture. Such practical and theoretical considerations have made the study of soil fungi a major area of mycological research.

In the United States, Abbott (1), Jensen (30), and Waksman (48) were pioneer soil mycologists. Among these, Waksman's studies were particularly notable and had a world-wide impact. In the United States, studies on soil fungi have been carried out in Colorado (35), Georgia (21, 39), Hawaii (31), Iowa (42), Louisiana (1), Mississippi (6), New Jersey (48), New York (30), Ohio (12, 52), the Sonoran Desert (43), the southern states (22, 24), Texas (51), and Wisconsin (10, 47).

Previous studies on soil fungi in Ohio have been concerned with the microfungi of cultivated or disturbed soils (12, 52). The present study was undertaken to chart the soil fungus population of non-agricultural, relatively undisturbed soils in central and southern Ohio. The emphasis here has been chiefly qualitative rather than quantitative. Two new fungi and several interesting fungi have been reported elsewhere (26, 27, 28, 29).

MATERIALS AND METHODS

Twenty-two soil samples were collected from non-agricultural, relatively undisturbed, forested or grassy sites in central and southern Ohio (Table I). The locations of soil samples were as follows: Sample 1, "Cedar Swamp," 3 miles north of Springfield on Route 68; Sample 2, Cincinnati; Sample 3, half mile east of Hillsboro on

Table I.

Predominant vegetation, pH, and number of fungi of Ohio soils

	Soil number and locality	Date sampled	Predominant vegetation	pH	Number of fungi, in thousands, per gram of dry soil
1.	Clark Co.	6/28/72	evergreen forest[a]	7.6	144
2.	Hamilton Co.	6/29/72	deciduous forest[b]	7.0	68
3.	Highland Co.	6/29/72	deciduous forest[c]	5.6	80
4.	Ross Co.	6/30/72	evergreen forest[d]	5.6	124
5.	Franklin Co.	5/30/72	grasses	7.5	248
6.	Athens Co.	7/6/72	deciduous forest[e]	4.8	264
7.	Athens Co.	7/6/72	evergreen forest[f]	5.1	72
8.	Athens Co.	7/7/72	grasses	5.7	64
9.	Noble Co.	7/7/72	deciduous forest[g]	5.4	100
10.	Belmont Co.	7/7/72	deciduous forest[h]	5.8	120
11.	Belmont Co.	7/7/72	deciduous forest[i]	5.6	280
12.	Muskingum Co.	7/7/72	deciduous forest[j]	5.9	148
13.	Clark Co.	6/28/72	deciduous forest[k]	7.6	72
14.	Athens Co.	7/6/72	deciduous forest[l]	5.8	200
15.	Athens Co.	7/6/72	evergreen forest[m]	4.8	236
16.	Scioto Co.	8/23/72	deciduous forest[n]	6.5	40
17.	Adams Co.	8/23/72	grasses	6.0	82
18.	Adams Co.	8/23/72	deciduous forest[o]	6.2	200
19.	Adams Co.	8/23/72	grasses	6.8	76
20.	Clermont Co.	8/23/72	deciduous forest[p]	6.1	132
21.	Montgomery Co.	8/23/72	deciduous forest[q]	7.2	136
22.	Union Co.	10/17/72	deciduous forest[r]	6.7	112

a. *Thuja occidentalis* L. b. *Acer saccharum* Marsh., *Morus rubra* L., *Quercus alba* L. c. *Acer saccharum*, *Carya ovata* (Mill.) K. Koch, *Cornus florida* L., *Quercus alba*. d. *Pinus resinosa* Ait., *P. strobus* L. e. *Quercus alba*, *Q. velutina* Lam. f. *Picea pungens* Engelm. g. *Acer saccharum*, *Fagus grandifolia* Ehrh. h. *Fagus grandifolia*, *Quercus alba*. i. *Acer saccharum*, *Quercus alba*. j. *Fagus grandifolia*, *Liriodendron tulipifera* L. k. *Fraxinus pennsylvanica* Marsh. var. *subintegerrima* (Vahl.) Fern., *Platanus occidentalis* L. l. *Acer saccharum*, *Quercus alba*, *Q. borealis* Michx. f., *Q. muehlenbergii* Engelm. m. *Pinus strobus*. n. *Liriodendron tulipifera*, *Platanus occidentalis*. o. *Quercus alba*. p. *Acer saccharum*, *Quercus alba*, *Quercus rubra* L., *Ulmus americana* L. q. *Celtis occidentalis* L. r. *Acer saccharum*, *Fagus grandifolia*.

Route 50; Sample 4, 9 miles northeast of Chillicothe; Sample 5, 1 mile south of Columbus on Route 23; Sample 6, southeast facing, upper part of a slope, 12 miles west of Athens; Sample 7, top of a hill, 14 miles west of Athens; Sample 8, lower part of a slope, 5 miles east of Athens; Sample 9, top of a hill, 1 mile east of Belle Valley; Sample 10, North Woods, 4 miles southeast of Belmont; Sample 11, South Woods, 4 miles southeast of Belmont; Sample 12, road side, 10 miles northwest of Zanesville on Route 146; Sample 13, 3 miles north of Springfield on Route 68; Sample 14, northeast-facing, upper part of a slope, 12 miles west of Athens; Sample 15, the middle part of a slope, 14 miles west of Athens; Sample 16, 2 miles northeast of Portsmouth; Sample 17, the middle part of a slope, 1 mile west of Lynx; Sample 18, 1 mile east of West Union; Sample 19, 1 mile west of West Union; Sample 20, one and one-half miles east of Bethel; Sample 21, 6 miles south of Dayton; Sample 22, half mile southeast of Byhalia on Route 31. At each site the surface litter and 1-2 cm of the surface soil were removed. The samples were then taken from three equidistant points (4 feet apart) of the areas thus exposed and brought to the laboratories in Columbus, Ohio. The samples from each site were mixed and air-dried for 2-5 da depending on wetness and stored at 3 C in a cold room. The pH of each sample was determined at the time isolations were made with a Beckman pH Meter from a 1:3 soil-water (v/v) mixture that had equilibrated for 20 min.

Isolations were made 1-2 mo later by four methods. Gochenaur's ammonium nitrate agar (GAN) (18) was used as the isolation medium except when hair was used as a bait. GAN contains rose bengal to reduce fungal colony spread and streptomycin to inhibit bacteria.

The dilution plate method was similar to that used by Barron (8). Twenty-five grams of each sample were mixed with sterile distilled water and diluted in four concentrations ranging from 1/100 to 1/100,000. One ml of dilution was pipetted into each of three sterile petri dishes and mixed with melted GAN. This method not only permitted the isolation of a variety of fungi but also yielded data on the number of fungi per gram of dry soil. The alcohol treatment method involving the use of soil plates was that described by Mahoney _et al_. (38).

The heat incubation method was designed to select thermophilic fungi from soil. One-tenth gram of soil was placed in each of three dry, sterile petri dishes. Into these was poured a layer of warm (45 C) GAN. The plates were then gently rotated to distribute the soil particles and incubated at 47-48 C.

The hair-baiting method was used to isolate keratinophilic fungi. A sterilized petri dish was half filled with soil, to which was added sterile distilled water in an amount just covering the soil. Sterilized horse hairs cut into 1 cm lengths were placed on the surface of the soil. The petri plates were incubated at room temperature for 2-4 wk, and colonies developing on or around the hair were transferred to Sabouraud's agar slants.

Following 4-5 da incubation for dilution and alcohol-treated plates and 3 da for heated plates, hyphal tip transfers were made from all developing colonies to malt agar slants. Sub-cultures derived from the heat incubation method were incubated in a 47-48 C incubator for 7 da to assure good growth, whereas cultures obtained by the other methods were incubated in the laboratory at room temperature for two wk. The cultures were sorted into presumed specific entities on the basis of such macroscopic appearance as colony color, texture, and sporulation; and one tube representing each presumed fungal species was assigned a number. Duplicates were discarded. Identifications were made by growing the keratinophilic fungi on Sabouraud's agar, the thermophilic fungi on yeast-starch agar (17), the mucoraceous fungi on Mucor synthetic agar (23), and the others on cornmeal agar (20), Czapek-Dox, and malt extract agars (44).

RESULTS

A. Numbers of fungi

The number of fungi ranged from 40,000 to 280,000 per gram of dry soil, with an average of 136,300. Exclusive of several species of *Penicillium*, the number of species per sample ranged from 7 to 35 with an average of about 20. There was no relationship between pH and the number of fungi per gram of dry soil. Likewise, there was no relationship between the number of species isolated and pH or the number of fungi per gram of dry soil.

B. Kinds of fungi

A total of 180 species and one variety belonging to 84 genera were isolated and identified. These can be divided as follows: phycomycetes-26, ascomycetes-43, and deuteromycetes-112. No basidiomycetes were isolated. The species, together with the data on localities from which they were isolated, are listed in Table II. The schemes for classifying the Ohio soil fungi were those by Barron (7) for the hyphomycetes and by Ainsworth *et al*. (3) for the other fungi.

Species of *Penicillium* occurred with the highest frequency, being isolated from 22 samples, followed in a decreasing order by species of *Trichoderma* (21 samples), *Mortierella* (17 samples), and *Talaromyces* (14 samples). The genus which contained the greatest number of species was *Penicillium*, being represented by at least 32 species and accounting for about 18% of the total number of species. This was followed by *Mortierella* (11 species), *Talaromyces* (7 species), *Trichoderma* (7 species), *Chaetomium* (6 species), *Mucor* (6 species), and *Paecilomyces* (6 species).

Of the 26 species of phycomycetous fungi, only one, *Brevilegnia diclina*, was an oomycete. The Zygomycetes were represented by the genera *Absidia*, *Circinella*, *Cunninghamella*, *Gongronella*, *Mortierella*, *Mucor*, *Rhizopus*, and *Zygorhynchus*. The most abundant phycomycete was *Mortierella nana*, with *Mucor hiemalis* next in frequency.

Although ascomycetes were widely distributed in the Ohio soils, they occurred relatively infrequently with the exception of *Talaromyces luteus* and *T. trachyspermus*, which were isolated from 8 and 10, respectively, of the 22 collection sites. Of the 43 species of ascomycetes, 14

Table II.

Fungi isolated from Ohio soils by means of the dilution plate (D), alcohol treatment (A), heat incubation (HI), and hair-bait (HB) methods.

Locality number of soil samples	Isolation method	Fungus	Frequency[a]
		Saprolegniales	
		Saprolegniaceae	
16	D	*_Brevilegnia diclina_ Harvey	4.6
		Mucorales	
		Cunninghamellaceae	
19, 20	D	_Cunninghamella elegans_ Lendner	9.1
		Mortierellaceae	
1, 2, 4, 21	D	_Mortierella alpina_ Peyronel	18.2
4, 10, 11, 18	D	_M. isabellina_ Oud. & Koning	18.2
3, 4, 6, 7, 11, 12, 18	D	_M. marburgensis_ Linnemann	31.8
10	D	_M. minutissima_ van Tiegh.	4.6
20	D	+_M. mutabilis_ Linnemann	4.6
3, 4, 6, 7, 9, 10, 11, 12, 14, 15, 16, 18, 20	A	_M. nana_ Linnemann	59.1
4, 11	D	_M. parvispora_ Linnemann	9.1
10, 16, 20	D	_M. ramanniana_ (Möller) Linnemann	13.6
1	D	+[b]_M. sossauensis_ Wolf	4.6
6, 7, 11, 12	A, D	_M. vinacea_ Dixon-Stewart	18.2
13	D	_M. zonata_ Linnemann	4.6
		Mucoraceae	
11	D	_Absidia californica_ Ellis & Hesseltine	4.6
7, 15	D	_A. cylindrospora_ Hagem	9.1
14, 19	D	_A. spinosa_ Lendner	9.1
20	D	_Circinella_ sp.	4.6
20	D	*_Gongronella butleri_ (Lendner) Peyronel & Dal Vesco	4.6
3	D	_Mucor corticolus_ Hagem	4.6

8	D	*M. fragilis* Bain.	4.6
18	D	*M. griseo-cyanus* Hagem	4.6
3, 4, 8, 15, 16, 18, 21, 22	D	*M. hiemalis* Wehmer	36.4
22	A	*M. mucedo* (L.) Fres.	4.6
9, 22	D	*M. racemosus* Fres.	9.1
17	D	*Rhizopus arrhizus* Fischer	4.6
3, 4, 6, 8	D	*Zygorhynchus moelleri* Vuill.	18.2
		Eurotiales	
		Eurotiaceae	
17	A	**Byssochlamys nivea* Westling	4.6
5, 19	A	+**Dichotomomyces cejpii* (Mil'ko) Scott	9.1
20	A	**Eupenicillium levitum* (Raper & (Fennell) Stolk & Scott	4.6
18	A	*Eupenicillium* sp.	4.6
1, 17	A	+**Eurotium chevalieri* Mangin	9.1
1, 5, 16, 17, 18, 19	A	+*E. chevalieri* var. *intermedium* (Thom & Raper) Malloch & Cain	27.3
22	A	+*E. rubrum* Konig, Spieckermann & Bremer	4.6
20	A	**Hamigera avellanea* Stolk & Samson	4.6
21	A	**Sartorya fumigata* Vuill.	4.6
11, 13, 16, 17, 18, 19	A	**Talaromyces flavus* (Klöcker) Stolk & Samson var. *flavus* Stolk & Samson	27.3
17	A	+*T. helicus* C.R. Benjamin var. *helicus* Stolk & Samson	4.6
4, 7, 8, 11, 13, 16, 17, 19	A	+*T. luteus* (Sacc.) Stolk & Samson	36.4
1, 4, 5, 11, 12, 13, 16, 17, 18, 19	A	*T. trachyspermus* (Shear) Stolk & Samson	45.6
5	A	+*T. ucrainicus* Udagawa	4.6
16, 19	A	+*T. udagawae* Stolk & Samson	9.1
10, 11, 12, 16, 19, 20	A, D	*T. wortmannii* C.R. Benjamin	27.3

		Gymnoascaceae	
5, 13	A	+*Eleutherascus lectardii (Nicot) von Arx	9.1
		Pseudeurotiaceae	
16	A	+*Pseudeurotium punctatum Panasenko	4.6
16, 17, 19	A	P. zonatum van Beyma	13.6
		Thermoascaceae	
21	HI	*Thermoascus aurantiacus Miehe	4.6
		Sphaeriales	
		Diaporthaceae	
10	D	+*Gnomonia sp.	4.6
		Hypocreaceae	
5	D	+*Nectria episphaeria (Tode ex Fr.) Fr.	4.6
		Melanosporaceae	
22	A	Chaetomium cochliodes Palliser	4.6
22	A	C. funicolum Cooke	4.6
14	A	C. seminudum Ames	4.6
18	D	C. spirale Zopf	4.6
22	A	+C. subspirale Chivers	4.6
6, 10	D	+C. torulosum Bain.	9.1
22	A	+*Petriella guttulata Barron & Cain	4.6
		Sordariaceae	
16	A	*Coniochaeta sp.	4.6
15	A	+*Diplogelasinospora princeps Cain	4.6
21	A	+*Gelasinospora cerealis Dowding	4.6
10	D	Sordaria fimicola (Rob.) Cesati	4.6
22	A	+*Strattonia minor Lundqvist	4.6
22	A	+Strattonia sp.	4.6
21	A	+*Triangularia backusii Huang	4.6

SEE ERRATA

		Pleosporales	
		Sporormiaceae	
1, 13	D	***Sporomiella leporina* (Niessl) Ahmed & Cain	9.1
		Pezizales	
		Ascobolaceae	
16	A	+*[c]*Ascobolus epimyces* (Cooke) Seaver	4.6
16, 18	A	+**Saccobolus globuliferellus* Seaver	9.1
		Pyronemataceae	
17, 18, 22	A	+**Ascodesmis nigricans* van Tiegh.	13.6
3, 19, 20, 21	A	+*A. sphaerospora* Obrist	18.2
19	A	+*[d]*Coprotus niveus* (Fuckel) Kimbrough, Luck-Allen & Cain	4.6
22	A	**Trichophaea abundans* (Karst.) Boud.	4.6
		Moniliales	
		Aleuriosporae	
19	HB	*Chrysosporium keratinophilum* (Frey) Carmichael	4.6
8, 11, 12, 18, 21	D, HB	+**Diheterospora chlamydosporia* (Goddard) Barron & Onions	22.7
4, 12, 13, 20	HI	*Humicola grisea* Traaen var. *thermoidea* Cooney & Emerson	18.2
1, 9	A	+[e]*Monosporium apiospermum* Sacc. Conidial state of *Allescheria boydii* Shear	9.1
1	A	*Mycogone* sp.	4.6
17, 22	HI	*Sporotrichum thermophile* Apinis	9.1
13	D	+**Staphylotrichum coccosporum* Meyer & Nicot	4.6
13, 16	D	+**Trichocladium canadense* Hughes	9.1
20	HB	*Trichophyton terrestre* Durie & Frey	4.6
		Annellosporae	
16	D	+*Doratomyces microsporus* (Sacc.) Morton & Smith	4.6
17	D	+*Scopulariopsis candida* (Guéguen) Vuill.	4.6

		Arthrosporae	
17	HI	*Malbranchea pulchella Sacc. & Penzig var. sulfurea (Miehe) Cooney & Emerson	4.6
4, 7	D	*Oidiodendron flavum Szilvinyi	9.1
		Blastosporae	
2	D	Aureobasidium pullulans (de Bary) Arnaud	4.6
16	D	Candida sp.	4.6
5, 13	D	Cladosporium cladosporioides (Fres.) de Vries	9.1
5	D	C. herbarum Link ex Fr.	4.6
13, 16	A	+Periconia igniaria Mason & Ellis Conidial state of Didymosphaeria igniaria Booth	9.1
		Meristem Blastosporae	
5	D	Arthrinium phaeospermum (Corda) M.B. Ellis	4.6
		Phialosporae	
8, 9, 11, 16	HI	Acremonium alabamensis G. Morgan-Jones	18.2
5, 13	A, D	A. curvulum W. Gams	9.1
2, 3, 10, 12, 13, 19	D	A. strictum W. Gams	27.3
16	D	Acremonium sp.	4.6
19, 21	D	Aspergillus flavipes (Bain. & Sart.) Thom & Church	9.1
1, 2, 3, 9, 10, 11, 16, 21	HI	A. fumigatus Fres.	36.4
22	D	A. sydowi (Bain. & Sart.) Thom & Church	4.6
18	A	A. terreus Thom	4.6
2	D	+*Cephalosporiopsis sp.	4.6
11	D	*Chloridium chlamydosporis (van Beyma) Hughes	4.6
1, 3, 16, 19	D	+Cylindrocarpon destructans (Zins.) Scholten	18.2
18	D	Cylindrocarpon sp. I	4.6
18	D	Cylindrocarpon sp. II	4.6
19	D	Fusarium moniliforme (Sheldon) Snyder & Hansen	4.6

3, 8, 13, 16, 18, 19, 20, 21	D	_F. oxysporum_ (Schlecht.) Snyder & Hansen	36.4
1, 8, 13	D	_F. solani_ (Mart.) Sacc. emend. Snyder & Hansen	13.6
10	D	+*_Gliocephalotrichum ohiense_ Huang & Schmitt	4.6
5	D	_Gliocladium deliquescens_ Sopp	4.6
5, 8, 13, 18, 19, 21	D	_G. roseum_ Bain.	27.3
14	D	_G. virens_ Miller, Giddens & Foster	4.6
5	D	_Gliomastix murorum_ (Corda) Hughes var. _felina_ (Marchal) Hughes	4.6
3	D	*_Gonytrichum macrocladium_ (Sacc.) Hughes	4.6
1, 8, 16, 19, 20, 21	D	*_Metarrhizium anisopliae_ (Metsch.) Sorok.	27.3
11	D	+_Paecilomyces bacillisporus_ Onions & Barron	4.6
3, 7, 8, 16, 20, 21	D	_P. carneus_ (Duché & Heim) Brown & Smith	27.3
8, 16	D	_P. elegans_ (Corda) Mason & Hughes apud Hughes	9.1
21	D	+_P. fumoso-roseus_ (Wize) Brown & Smith	4.6
1, 5, 7, 8, 18, 20, 21	D, HB	_P. marquandii_ (Massee) Hughes	31.8
14	A	_P. varioti_ Bain.	4.6
19	D	_Penicillium brevi-compactum_ Dierckx	4.6
12, 20	D	_P. brevi-compactum_ series I	9.1
12	D	_P. brevi-compactum_ series II	4.6
14, 15, 17	D	_P. citrinum_ Thom	13.6
19	D	_P. commune_ series I	4.6
20	D	_P. commune_ series II	4.6
10, 12	A	_P. corymbiferum_ Westling	9.1
17	D	_P. cyclopium_ Westling	4.6
11, 18	D	+_P. daleae_ Zaleski	9.1
11, 15, 17	D	_P. frequentans_ Westling	13.6

14	A	*P. frequentans* series	4.6
20	D	*P. funiculosum* Thom	4.6
3, 11, 14, 18	A, D	*P. granulatum* Bain.	18.2
20	D	*P. janthinellum* Biourge	4.6
11, 15, 18, 20, 21	D	*P. nigricans* (Bain.) Thom	22.7
11	D	*P. nigricans* series	4.6
16	A	*P. notatum* Westling	4.6
6, 20	D	*P. purpurogenum* Stoll	9.1
18, 19	A	*P. raistrickii* Smith	9.1
20	D	*P. raistrickii* series	4.6
15, 17, 18, 19	A, D	*P. roqueforti* Thom	18.2
17, 18, 19, 21	A, D	*P. rubrum* Stoll	18.2
10	A	*P. rugulosum* Thom	4.6
14	D	*P. steckii* Zaleski	4.6
12	D	*P. stoloniferum* Thom	4.6
19	A	*P. thomii* Maire	4.6
10	A	*P. thomii* series I	4.6
3, 9, 11, 15, 18	A	*P. thomii* series II	22.7
12, 16, 17, 18, 19	A	*P. thomii* series III	22.7
7, 10, 12	D	*P. velutinum* van Beyma	13.6
12, 20, 21	D	*P. waksmani* Zaleski	13.6
1, 2, 3, 4, 5, 6, 7, 8, 13, 16, 22	A, D	*Penicillium* spp.	
1	A	*Phialophora* sp.	4.6
3, 16, 21	D	*Stachybotrys cylindrospora* Jensen	13.6
7, 12, 17	D	+*Trichoderma aureoviride* Rifai	13.6
1, 3, 4, 5, 7, 9, 12, 14, 18, 20, 22	D	*T. hamatum* (Bon.) Bain	50.0
2, 8, 9, 10, 11, 16, 19	D	+*T. harzianum* Rifai	31.8
1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 16, 17, 18, 19, 22	D	*T. koningii* Oud.	77.3
21	D	*T. longibrachiatum* Rifai	4.6

3, 4, 6, 8, 14, 18, 20, 21, 22	D	T. polysporum (Link ex Pers.)Rifai	40.9
14	A	T. pseudokoningii Rifai	4.6
3	D	Verticillium cephalosporium W. Gams	4.6
7	D	V. psalliotae Treschow	4.6
11	D	Verticillium sp.	4.6
13	D	Volutella ciliata Fr.	4.6
		Porosporae	
5	HI	Torula thermophila Cooney & Emerson	4.6
		Sympodulosporae	
3, 6, 7, 11, 12, 18, 21	D	Beauveria bassiana (Bals.) Vuill.	31.8
18	D	+*Cordana pauciseptata Preuss	4.6
2	D	Dactylaria sp.	4.6
1, 2, 5, 8, 9, 11, 13, 16, 18, 19	A	+*Geniculisporium serpens Chesters & Greenhalgh	45.6
1, 4, 9, 10, 11, 14, 16, 18, 19	A	+*Nodulisporium sp.	40.9
17, 19	A, D	Rhinocladiella mansonii (Cast.) Schol-Schwarz	9.1
		Melanconiales	
		Melanconiaceae	
16	D	Pestalotia lespedezae Syd.	4.6
4	D	P. mangifolia Guba	4.6
		Sphaeropsidales	
		Sphaeropsidaceae	
19	D	Coniothyrium fuckelii Sacc.	4.6
1, 3, 16, 18	D	Coniothyrium sp.	18.2
15	A	Phoma prunicola (Opiz) Wollenw. & Hochapf.	4.6
1, 8, 18	A, D	Phoma sp. I	13.6
3	D	Phoma sp. II	4.6
13	D	Phoma sp. III	4.6

13	D	Phomopsis sp.	4.6
10	D	Pyrenochaeta decipiens Marchal	4.6
5	D	Pyrenochaeta sp.	4.6
		Mycelia Sterilia	
11, 14, 20, 22	A	Rhizoctonia solani Kühn	18.2

---

* First report of this genus from Ohio soils.

+ Species preceded by a plus (+) are reported for the first time from soil in the United States

[a] Frequency is expressed as the number of samples from which isolates were obtained divided by the total of 22 samples

[b] Identified by W. Gams

[c] Confirmed by J. van Brummelen

[d] Confirmed by J. W. Kimbrough

[e] Identified by M. B. Ellis

were ascocarpic Aspergilli and Penicillia belonging in the genera Eurotium, Sartorya, Eupenicillium, Hamigera, and Talaromyces. Members of the Melanosporaceae and the Sordariaceae isolated included the following: 6 species of Chaetomium, one species of Petriella, two species of Strattonia, and one species each of Coniochaeta, Diplogelasinospora, Gelasinospora, Sordaria, and Triangularia. Ascobolus and Saccobolus of the Ascobolaceae, and Ascodesmis, Coprotus, and Trichophaea of the Pyronemataceae were among the discomycetous genera whose members were isolated.

Nearly two thirds of the total 180 species isolated can be assigned to the Deuteromycetes. Isolates of Penicillium and Trichoderma dominated both in frequency and in the number of species represented. Among the Penicillia, Penicillium nigricans, P. thomii series II, and P. thomii series III had a frequency of 22.7% each, whereas Trichoderma koningii and T. hamatum had high frequencies of 77.3% and 50%, respectively. Other fungi which had a frequency of more than 22.7% included Geniculisporium serpens (45.6%), Nodulisporium sp. (40.9%), Trichoderma polysporum (40.9%), Aspergillus fumigatus (36.4%), Fusarium oxysporum (36.4%), Beauveria bassiana (31.8%), Paecilomyces marquandii (31.8%), Trichoderma harzianum (31.8%), Acremonium strictum (27.3%), Gliocladium roseum (27.3%), Metarrhizium anisopliae (27.3%), Paecilomyces carneus (27.3%), and Diheterospora chlamydosporia (22.7%). The dematiaceous fungi made up about one fifth of the total 99 species of Hyphomycetes.

C. Effect of dominant plants on distribution

A few features in the distribution data may be significant. In the main, only two kinds of vegetation were represented in the sample collection areas: forests (18 samples) and grasses (4 samples). All species of *Mortierella* occurred only in forested soils, whereas species of *Fusarium*, *Eurotium chevalieri* var. *intermedium*, and *Pseudeurotium zonatum* were found in both grassland and forest soils. The following fungi were obtained only from grassland soils: *Arthrinium phaeospermum*, *Byssochlamys nivea*, *Coniothyrium fuckelii*, *Coprotus niveus*, *Chrysosporium keratinophilum*, *Cladosporium herbarum*, *Dichotomomyces cejpii*, *Fusarium moniliforme*, *Gliocladium deliquescens*, *Gliomastix murorum* var. *felina*, *Mucor fragilis*, *Nectria episphaeria*, *Rhinocladiella mansonii*, *Talaromyces helicus*, *T. ucrainicus*, *Penicillium brevicompactum*, *P. commune* series I, *P. thomii*, and *Pyrenochaeta* sp.

D. Effect of pH on distribution

The pH of soil samples ranged from 4.8 to 7.6, with 4 out of 22 samples having values above 7.0. The fungi occurring exclusively in alkaline soil samples (pH 7.2-7.6) included *Acremonium curvulum*, *Arthrinium phaeospermum*, *Cladosporium cladosporioides*, *C. herbarum*, *Eleutherascus lectardii*, *Gelasinospora cerealis*, *Gliocladium deliquescens*, *Gliomastix murorum* var. *felina*, *Mortierella sossauensis*, *M. zonata*, *Mycogone* sp., *Nectria episphaeria*, *Paecilomyces fumoso-roseus*, *Phialophora* sp., *Phoma* sp. III, *Phomopsis* sp., *Pyrenochaeta* sp., *Sartorya fumigata*, *Sporormiella leporina*, *Staphylotrichum coccosporum*, *Talaromyces ucrainicus*, *Thermoascus aurantiacus*, *Torula thermophila*, *Trichoderma longibrachiatum*, and *Volutella ciliata*. *Fusarium solani*,*Gliocladium roseum*, and *Mortierella alpina* also occurred in alkaline samples, although they were isolated from acidic samples as well. On the other hand, all species of *Mortierella* except *M. alpina*, *M. sossauensis*, and *M. zonata* occurred only in the acidic samples.

When fungi occurring in 4 alkaline samples (pH 7.2-7.6) and 4 very acidic samples (pH 4.8-5.4) were analyzed, and frequency was expressed as percentage of a total of 4 samples from which a fungus was isolated, an interesting result emerged. Species of *Trichoderma* seemed to be able to tolerate a wide range of soil pH. *Trichoderma koningii* and *T. hamatum* occurred at frequencies of 75% and 50%, respectively, in both alkaline and very acidic samples. In the very acidic samples, *Mortierella nana* was present at a frequency of 100%; species at a frequency of 50% were *Absidia cylindrospora*, *Beauveria bassiana*, *Mortierella marburgensis*, *M. vinacea*, and *Penicillium thomii* series II. In the alkaline samples, those having a frequency of 75% were *Geniculisporium serpens*, *Gliocladium roseum*, *Paecilomyces marquandii*, and *Talaromyces trachyspermus*; those having a frequency of 50% were *Acremonium curvulum*, *Aspergillus fumigatus*, *Cladosporium cladosporioides*, *Eleutherascus lectardii*, *Eurotium chevalieri* var. *intermedium*, *Fusarium solani*, *F. oxysporum*, *Metarrhizium anisopliae*, *Mortierella alpina*, and *Sporormiella leporina*.

E. Effect of isolation methods

One hundred and four fungi were isolated only by the dilution plate method, 57 fungi only by the alcohol treatment method, and 9 fungi by both methods. Of the 115 fungi obtained from the dilution plate method, 24 were phycomycetes, 7 were ascomycetes, and 84 were deuteromycetes. Among the 66 fungi isolated following alcohol treatment, 3 were phycomycetes, 36 were ascomycetes, and 27 were deuteromycetes. The 36 ascomycetes obtained by the alcohol treatment accounted for about 84% of the ascomycete species and nearly 20% of the total species.

Seven fungi were isolated only by the heat incubation method. *Aspergillus fumigatus* could be classified as a thermotolerant, with maximum temperatures for growth near 50 C but minima well below 20 C. The other six species, *Acremonium alabamensis*, *Humicola grisea* var. *thermoidea*, *Malbranchea pulchella* var. *sulfurea*, *Sporotrichum thermophile*, *Thermoascus aurantiacus*, and *Torula thermophila*, were true thermophiles in the sense of Cooney and Emerson (13). Four fungi, *Chrysosporium keratinophilum*, *Trichophyton terrestre*, *Diheterospora chlamydosporia*, and *Paecilomyces marquandii*, were obtained by the hair-baiting method, although the latter two fungi also were isolated by the dilution plate method.

DISCUSSION

The numbers of fungi per gram of soil in Ohio were lower than in forest and cultivated soils in Georgia (39) and forest soils in southern Wisconsin (11) but were higher than in soils of sandbar willow stands in southern Wisconsin (19) and Sonoran Desert soils (43). Tresner *et al*. (47) and Miller *et al*. (39) reported that the numbers of fungi per gram of soil may vary with season and soil depth. Stotzky *et al*. (46) noted that numbers of fungi were higher in samples after storage from all soil depths, except from the top layer where essentially no change occurred. In addition, the disturbance of soil, such as that caused by cultivation or human activity, may have an effect on numbers.

Among the 84 genera, including 180 species and one variety, 40 are reported from Ohio soils for the first time (Table II). Williams and Schmitthenner (52), studying soil fungi of cropped fields in Ohio, isolated fungi belonging in 81 genera, some of which were either doubtful or synonymous. From his back-yard in Cincinnati, Ohio, Cooke (12) obtained at least 52 fungal species in 36 genera, while Kurup and Schmitt (33) found 9 keratinophilic fungi and 2 fungi pathogenic for humans in such areas as zoos, river banks, and picnic places in central Ohio. In total, with the addition of some soil fungi reported in the phytopathological literature, there have been at least 293 species in 141 genera reported from soils of Ohio.

The order of dominant genera whose members were isolated from Ohio samples was similar to that reported by Miller *et al*. (39), who found that *Penicillium*, *Aspergillus*, *Cunninghamella*, and *Trichoderma* were the chief genera in Georgia soils. Except for *Aspergillus fumigatus*, members of *Aspergillus* were poorly represented in the soil fungus populations in Ohio. The present study supports the idea that Penicillia are dominant in temperate and cool areas, whereas Aspergilli are common in tropical and subtropical soils (9, 16, 39). Comparison of the mycota of Ohio soils with those of other areas is often difficult, since there are differences in isolation techniques, isolation media, collecting seasons, depth of sampling, or combinations of any of these factors.

Although the present study is the result of using only one isolation medium and four isolation techniques, two fungi were new and many were of rare occurrence. Of the 84 genera whose members were obtained in this study, 4 (Coprotus, Gnomonia, Petriella, and Saccobolus) appear to have been unrecorded from soil previously. The genera whose members are infrequently reported from the soil include Arthrinium, Ascodesmis, Byssochlamys, Cephalosporiopsis, Cordana, Dichotomomyces, Diplogelasinospora, Eleutherascus, Geniculisporium, Hamigera, Mycogone, Nectria, Nodulisporium, Pestalotia, Pseudeurotium, Sporormiella, Staphylotrichum, Strattonia, Thermoascus, and Triangularia.

The distribution of species of Mortierella and Fusarium in Ohio soils agrees with the well documented idea that Mortierella spp. are forest fungi (11, 22, 53) and Fusarium spp. are grassland forms (16, 25). The distribution of the other fungi in the two types of vegetation, however, is not known and needs further study. The pH values obtained for Ohio soils agree closely with those obtained by Miller et al. (39) for forest and cultivated soils in Georgia, which ranged from pH 4.5 to 7.1. Many of the Ohio samples have pH values falling into the pH range (5.3-6.7) of wet-mesic forests in southern Wisconsin (11). It is not known how the soil pH affects the growth of soil fungi. Species of Mortierella appear to be very sensitive to soil pH (53). This sensitivity, however, is less clear for other fungi. Four Ohio soil fungi, Fusarium solani, Gliocladium roseum, Paecilomyces marquandii, and Volutella ciliata, have been isolated from alkaline soils (9, 16). It is possible that these fungi can grow in the soil with a wide range of pH but prefer a slightly alkaline pH.

Of the four isolation methods used in this study, the dilution plate method has been most frequently used by soil mycologists and fungal ecologists. The alcohol treatment method has been used to isolate new or rarely-occurring fungi in soil (26, 27, 28, 29). This method, together with the heat incubation method and hair-baiting method, is somewhat more selective than the dilution plate method, which, as most previous studies have revealed, is effective in selecting fast growing fungi such as the members of the Mucorales and the Hyphomycetes.

The alcohol treatment method makes possible the detection of a larger portion of the ascomycetes in the soil population. Of the 66 different fungi isolated by this method, 36 were ascomycetes. The recovery of many ascomycetes by this procedure has been reported recently by Huang (25), Mahoney (37), and Satanimi (45). From Nigerian soils, Huang (25) secured 79 specific taxa, 35 species of which were ascomycetes; of 48 specific taxa isolated by Mahoney (37), 22 species were ascomycetes. Thirty-seven per cent of the species which Satanimi (45) obtained from Greek soils were ascomycetes. That the alcohol treatment method is very selective for soil ascomycetes is evident also from the reports of Warcup and Baker (49), Novak (41), Laube (34), Mahoney et al. (38), and Huang (26).

Although the eurotiaceous fungi (ascocarpic Penicillia and Aspergilli) usually predominate among the ascomycetes isolated from alcohol-treated soil, a diversity of small discomycetes, members of the Sphaeriales, an assortment of plectomycetous species, etc. are commonly secured in small numbers. The method has been acclaimed, for instance, for its ability to select members of the Sordariaceae. Ascospores of sordariaceous forms apparently are not numerous in the soil, but even when they are present only in low numbers, the alcohol technique often makes their detection possible. Probably because the ascospores are not very abundant and possibly also because many of them may require some sort of shock treatment before they will germinate, very few representatives of the Sordariaceae have even been reported in studies based on older isolation methods. Indeed, until recently, the Sordariaceae were considered to be almost exclusively a coprophilous group (36). There is now evidence, however, that they are relatively frequent and widely distributed in soil (25, 38). In the present study, representatives of the genera Gelasinospora, Diplogelasinospora, Strattonia, Triangularia, Sordaria, and Coniochaeta were encountered.

The isolation of 6 thermophilic fungi from soils from 12 different sites in Ohio suggests that these fungi are of widespread occurrence. In summer afternoons in Ohio, the heat from the sun might provide temperatures high enough for active growth of the thermophilic fungi (personal communication with M. R. Tansey). Although such widespread occurrence of the thermophiles in Ohio is surprising, it is worth noting that Ranzoni (43) did not obtain any thermophilic fungi from the Sonoran Desert - a place likely to provide an environment in which thermophiles might thrive. Failure to obtain thermophiles may be due to the differences in isolation media or sampling and isolation techniques. Thus far, studies of the thermophilic microfungi of the soil have been carried out in temperate and cool areas (4, 5, 15, 40, 50).

The subsurface soils in Ohio do not appear to be rich in keratinophilic fungi. In this study only three keratinophilic fungi were obtained. *Diheterospora chlamydosporia*, which has been cited as a cellulose and chitin decomposer (14), appears to be previously unrecorded from soils in the United States. Kurup and Schmitt (33) reported the presence of *Trichophyton terrestre* and *Chrysosporium keratinophilum* in central Ohio soils, and Knudtson and Robertstad (32) found *T. terrestre* in South Dakota soils. The fact that hairs used were not defatted might contribute to failure to isolate keratinophilic fungi. Moreover, since the sampling sites included in the present study were away from areas of concentrated human or animal activity, a paucity of keratinophilic fungi might be expected.

ACKNOWLEDGMENTS

The senior author sincerely expresses his appreciation to the Graduate School, The Ohio State University, for the award of a fellowship during 1972-73.

LITERATURE CITED

1. Abbott, E. V. 1926. Taxonomic studies on soil fungi. Iowa State Coll. J. Sci. 1:15-36.

2. Adametz, L. 1886. Untersuchungen uber die niederen Pilze der Ackerkrume. Inaug. Diss., Leipzig. 78 p.

3. Ainsworth, G. C., F. K. Sparrow, and A. S. Sussman (Ed.). 1973. The Fungi, An Advanced Treatise. Vols. IVA and IVB. Academic Press. New York and London.

4. Apinis, A. E. 1963. Occurrence of thermophilous microfungi in certain alluvial soils near Nottingham. Nova Hedwigia 5:57-78.

5. Awao, T., and S. Otsuka. 1974. Notes on thermophilic fungi in Japan (3). Trans. Mycol. Soc. Japan 15:7-22.

6. Bagga, D. K. 1970. Soil fungi of the Delta of Mississippi. Soil Science 109:247-249.

7. Barron, G. L. 1968. The Genera of Hyphomycetes from Soil. The Williams & Wilkins Company, Baltimore, 364 p.

8. Barron, G. L. 1971. Soil fungi. pp. 405-427. In Booth, C. (Ed.). Methods in Microbiology, Vol. 4. Academic Press, London and New York.

9. Bhatt, G. C. 1970. The soil microfungi of white cedar forests in Ontario. Canad. J. Bot. 48:333-339.

10. Christensen, M. 1969. Soil microfungi of dry to mesic conifer-hardwood forests in northern Wisconsin. Ecology 50:9-27.

11. Christensen, M., W. F. Whittingham, and R. O. Novak. 1962. The soil microfungi of wet-mesic forests in southern Wisconsin. Mycologia 54:374-388.

12. Cooke, Wm. B. 1973. Back-yard fungi. Ohio J. Sci. 73:88-96.

13. Cooney, D. G., and R. Emerson. 1964. Thermophilic Fungi. W. H. Freeman and Company. 188 p.

14. Domsch, K. H., and W. Gams. 1970. Pilze aus Agrarböden. Gustav Fischer Verlag, Stuttgart.

15. Eggins, H. O. W., and K. A. Malik. 1969. The occurrence of thermophilic cellulolytic fungi in a pasture land soil. Antonie van Leeuwenhoek 35:178-184.

16. Eicker, A. 1974. The mycoflora of an alkaline soil of the open-savannah of the Transvaal. Trans. Br. Mycol. Soc. 63:281-288.

17. Emerson, R. 1958. Mycological organization. Mycologia 50:589-621.

18. Gochenaur, S. E. 1964. A modification of the immersion tube method for isolating soil fungi. Mycologia 56:921-923.

19. Gochenaur, S. E., and M. P. Backus. 1967. Mycoecology of willow and cottonwood lowland communities in southern Wisconsin. II. Soil microfungi in the sandbar willow stands. Mycologia 59:893-901.

20. Grosklags, J. H., and M. E. Swift. 1957. The perfect stage of an antibiotic-producing *Cephalosporium*. Mycologia 49:305-317.

21. Hammill, T. M. 1970. *Paecilomyces clavisporis* sp. nov., *Trichoderma saturnisporum* sp. nov., and other noteworthy soil fungi from Georgia. Mycologia 62:107-122.

22. Hendrix, F. F., Jr., W. A. Campbell, and C. Y. Chien. 1971. Some phycomycetes indigenous to soils of old growth forests. Mycologia 63:283-289.

23. Hesseltine, C. W. 1954. The section *Genevensis* of the genus *Mucor*. Mycologia 46:358-366.

24. Hodges, C. S. 1962. Fungi isolated from southern forest tree nursery soils. Mycologia 54:221-229.

25. Huang, L. H. 1971. Studies on soil microfungi of Nigeria and Dominica. Ph.D. Thesis. Univ. of Wisconsin. 407 p.

26. Huang, L. H. 1975. A new species of *Triangularia* from Ohio soil. Canad. J. Bot. 53: 560-564.

27. Huang, L. H., and J. A. Schmitt. 1973. *Gliocephalotrichum ohiense*, a new species from Ohio soil. Mycologia 65:948-952.

28. Huang, L. H., and J. A. Schmitt. 1973. Ohio Ascomycete Notes I. On *Eleutherascus lectardii* (Nicot) von Arx. Ohio J. Sci. 73:234-237.

29. Huang, L. H., and J. A. Schmitt. 1975. Ohio Ascomycete Notes II. Talaromyces from soils of southern Ohio. Ohio J. Sci. 75:75-81.

30. Jensen, C. N. 1912. Fungus flora of the soil. N.Y. (Cornell) Agr. Exp. Sta. Bull. 315:415-501.

31. Kishimoto, R. A., and G. E. Baker. 1969. Pathogenic and potentially pathogenic fungi isolated from beach sands and selected soils of Oahu, Hawaii. Mycologia 61:537-548.

32. Knudtson, W. U., and G. W. Robertstad. 1970. The isolation of keratinophilic fungi from soil and wild animals in South Dakota. Mycopath. Mycol. Appl. 40:309-323.

33. Kurup, P. V., and J. A. Schmitt. 1970. Human-pathogenic fungi in the soils of central Ohio. Ohio J. Sci. 70:291-295.

34. Laube, E. V. 1966. Soil microfungi in the Andes Mountains of Peru. M.S. Research Report. Univ. of Wisconsin. 99 p.

35. LeClerg, E. L., and F. B. Smith. 1928. Fungi in some Colorado soils. Soil Sci. 25:433-441.

36. Lundqvist, N. 1972. Nordic Sordariaceae s. lat. Symb. Bot. Uppsala 22(1):1-374.

37. Mahoney, D. P. 1968. Soil microfungi of the Galapagos Islands and Ecuador isolated by a modification of the Warcup alcohol-treatment technique. M.S. Research Report. Univ. of Wisconsin. 123 p.

38. Mahoney, D. P., L. H. Huang, and M. P. Backus. 1969. New homothallic Neurosporas from tropical soils. Mycologia 61:264-272.

39. Miller, J. H., J. E. Giddens, and A. A. Foster. 1957. A survey of the fungi of forest and cultivated soils of Georgia. Mycologia 49:779-808.

40. Minoura, K., K. Ochi, and T. Nehira. 1973. Thermophilic filamentous fungi in Japan (2). Trans. Mycol. Soc. Japan 14:362-366.

41. Novak, R. O. 1963. The soil microfungi of a maple-elm-ash floodplain community at Avon, Wisconsin. Ph.D. Thesis. Univ. of Wisconsin. 190 p.

42. Paine, F. S. 1927. Studies of the fungous flora of virgin soils. Mycologia 19:248-267.

43. Ranzoni, F. V. 1968. Fungi isolated in culture from soils of the Sonoran Desert. Mycologia 60: 356-371.

44. Raper, K. B., and D. I. Fennell. 1965. The Genus Aspergillus. The Williams and Wilkins Co., Baltimore. 686 p.

45. Satanimi, L. 1971. Studies on soil microfungi of the Mt. Pelion highlands in Greece. M.S. Research report. Univ. of Wisconsin. 191 p.

46. Stotzky, G., R. D. Goos, and M. I. Timonin. 1962. Microbial changes occurring in soil as a result of storage. Plant & Soil 16:1-18.

47. Tresner, H. D., M. P. Backus, and J. T. Curtis. 1954. Soil microfungi in relation to the hardwood forest continuum in southern Wisconsin. Mycologia 46:314-333.

48. Waksman, S. A. 1916. Soil fungi and their activities. Soil Sci. 2:103-155.

49. Warcup, J. H., and K. F. Baker. 1963. Occurrence of dormant ascospores in soil. Nature 197:1317-1318.

50. Ward, J. E., and G. T. Cowley. 1972. Thermophilic fungi of some central South Carolina forest soils. Mycologia 64:200-205.

51. Werkenthin, F. C. 1916. Fungus flora of Texas soils. Phytopathology 6:241-253.

52. Williams, L. E., and A. F. Schmitthenner. 1956. Genera of fungi in Ohio soils. Ohio Agr. Exp. Sta. Res. Circular 39:1-7.

53. Zycha, H., R. Siepmann, and G. Linnemann. 1969. Mucorales. Verlag von J. Cramer, Lehre. 355 p.

MYCOTAXON

Vol. III, No. 1, pp. 81-88 October-December 1975

THE GENUS OSTREICHNION

MARGARET E. BARR

Department of Botany, University of Massachusetts, Amherst, MA 01002

SUMMARY

The genus *Ostreichnion* Duby is re-established for the type species, *O. sassafras* (Schw.) Barr, comb. nov., and for two additional species, *O. nova-caesariense* (Ellis) Barr, comb. nov. and *O. curtisii* (Duby) Barr, comb. nov. The species are known from eastern and southern North America.

The genus *Ostreichnion* Duby (1862) was created for two species, *O. europaeum* Duby and *O. americanum* Duby. Saccardo (1883) considered that *Ostreichnion* was an ill-conceived name and replaced it with *Ostreion* "Duby," with the single species *O. americanum*. However, by inference with the rejection of *Mytilidion* vs. *Mytilinidion* (Rogers 1953), *Ostreichnion* should be the name used, rather than *Ostreion*. Rehm (1886) studied Duby's specimens and recognized that *O. europaeum* was a pedicellate form of *Hysterium pulicare* Pers. ex Fries. *Ostreichnion americanum* typifies the genus, and was based upon a specimen on *Liquidambar* bark from South Carolina, sent to Duby by M.A. Curtis. Rehm found this collection to have conchate ascocarps, about 2 mm long, 1 mm wide, and up to 2½ mm high, with striate surface, overmature 4-spored asci and elongate ascospores which were 12-20-septate.

Clements and Shear (1931) consigned *Ostreichnion* (as *Ostreium* Duby) to synonymy with *Mytilinidion* Duby (as *Mytilidium*), although this genus was created later (p. 62) in Duby's monograph than was *Ostreichnion* (p. 21). Zogg (1962) used *Mytilidion*, with *Ostreion* as a synonym, basing his use of the later name on frequency of usage and the number of species recognized in *Mytilidion* over the years since its creation. The ascospores of *O. americanum* were said to be "multiseptate," a condition which would describe ascospores of *Mytilinidion* also. Bisby (1932) noted indications of longitudinal septa in the specimens he examined -- including *Lophium sassafras* Schw., an earlier name for the species. Bisby reported that Massee had said the ascospores were muriform but he believed that the longitudinal septa were only pseudosepta. The specimens examined in the present study show many vertical as well as transverse septa in the ascospores. The ascospores differ in this character from those of *Mytilinidion* species, as well as in shape: in *O. sassafras* the large ascospores are broadly fusoid or nearly cylindric and the end cells are lighter brown to nearly hyaline, while the species of *Mytilinidion* have ascospores which are variously elliptic, narrowly fusoid, clavate, or elongate and pigmentation is ± even throughout all cells.

Ostreichnion Duby is upheld as a valid genus of the Lophiaceae. The family characters of upright, nearly superficial, ± conchate ascocarps, deeply pigmented prosenchymatous peridium (quite brittle), and centrum of asci in narrow, branched and anastomosing pseudoparaphyses are met in the genus. The large muriform ascospores of the type species, which possess many transverse and one to five vertical septa, differ from those of *Ostreola* Darker (1963). *Ostreola consociata* Darker could conceivably be the lower end of a series of as yet unknown species which culminates in *Ostreichnion sassafras*; for the present I would recognize two muriform-spored genera in the Lophiaceae.

Another fungus which seems best placed in *Ostreichnion* is *Hysterium nova-caesariense* Ellis. This species is generally regarded as a species of *Hysterographium*, or as a synonym of *H. flexuosum* (Schw.) Sacc. by Zogg (1962). However, the ascocarps are conchate with a prosenchymatous peridium, a character of members of the Lophiaceae rather than the Hysteriaceae, and the centrum differs from that of typical Hysteriaceae. The ascospores are nearly cylindric, with numerous transverse and vertical septa.

A third species now added to *Ostreichnion* is the fungus known as *Glonium curtisii* (Duby) Lohman. The ascocarps are broadly conchate and the peridium is prosenchymatous; the centrum is similar to that of *O. sassafras*. The cylindric ascospores, however, are one-septate, with the septum submedian, and the walls at the tips, especially the upper one, are greatly thickened. When ascospores are observed in KOH, Melzer's, or Congo Red, the cytoplasm of mature ascospores is obviously divided into a number of segments. Lohman's (1937) description and illustration of ascospore germination by numerous germ tubes also gives the impression of a fungus with potentially muriform ascospores, as Lohman noted. I believe that *G. curtisii* is best regarded as a species of *Ostreichnion* in which ascospore septation is retarded and restricted to a single apparent septum.

The species of *Ostreichnion* are readily separated on the bases of ascospore sizes and septation:

1. Ascospores 1-septate, septum submedian, with thickened ends, (45-)62-80 x (10-)12-15 μ; asci 4-8-spored . . . . *O. curtisii*
1. Ascospores muriform 2
   2. Ascospores 35-45(-50) x 11-13 μ, with 7-13 transverse and 1-3 vertical septa in all or most cells; asci 8-spored . . . . *O. nova-caesariense*
   2. Ascospores (65-)76-100(-135) x 20-32 μ, with up to 27 transverse and 1-5 vertical septa in all or most cells; asci (1-2-)4-(5-6-)spored . . . *O. sassafras*

Ostreichnion sassafras (Schw.) Barr, comb. nov. Figs.1, 2

Lophium sassafras Schw. Trans. Amer. Phil. Soc. IV, n.s. 240, n. 2018. 1832.
Mytilidion sassafras (Schw.) Zogg, Beitr. Kryptogamenfl. Schweiz 11(3): 117. 1962.
Ostreichnion americanum Duby, Mém. Soc. Phys. Hist. Nat. Genève 16: 22. 1862.
Ostreion americanum (Duby) Sacc. Syll. Fung. 2: 765. 1883.

Ascocarps superficial, bases attached to and grown with substrate, conchate to nearly dolabrate, 1-1.5 mm wide and high, or up to 2 mm high, sides compressed, ± 750 μ wide, surface matt black, not shining, horizontally striate, occasionally triradiate, apex compressed along length, opening by long slit; in section pyriform, ovoid, or vertically elongate, peridium brittle, difficult to section, prosenchymatous, cells very small, densely encrusted with pigment, ± even in width at sides, 26-40 μ wide, 52-65 μ wide above, thickened at base to 104-115 μ wide. Asci arising from base, 220-330 x 30-40 μ, clavate-cylindric, bitunicate, apex thickened, with suggestion of refractive ring around cytoplasmic protrusion, base tapered and foot-like, (1-2-3-)4-(5-6-)spored; pseudoparaphyses narrow, branched and anastomosing, in gel matrix. Ascospores (65-) 76-100(-135) x 20-32 μ, yellowish to dark brown, opaque in age, end cells light brown or nearly hyaline, broadly fusoid to ± cylindric, tapered to rounded ends, 1-3- and up to 27 transversely septate, primary septum median, thickened and dark, slightly constricted, secondary septa cutting off end cells, tertiary septa intermediate and often one or two in end cells, 1-5 vertical septa in most cells, wall surface somewhat roughened and irregular.

On bark or decorticated wood of various trees, southeastern United States, from Pennsylvania to Florida. Also reported from China (Teng 1933).

Material examined: no data: Herb. W.R. Gerard. North Carolina: South Toe River, Yancy Co., 30 Nov 1933, on *Quercus*, M.L. Lohman 530; Mill Creek, Old Fort, 22 May 1934 on *Liriodendron*, M.L. Lohman 579; Yadkinville, 12 Apr 1935, on *Quercus alba*, M.L. Lohman 582. South Carolina: M.A. Curtis, Herb. G. Massee; mountains north of Pickens, 26 May 1935, on *Quercus rubra*, M.L. Lohman 580, and *Q. prinus*, 581; *Taxodium*, H.W. Ravenel; *'Laurus' (= Sassafras albidum)*, H.W. Ravenel. Georgia: Chattooga River, Rabun Co., 10 Mar 1934, on *Quercus rubra*, M.L. Lohman 583. Florida: Ocala, 1897-1898, R. Thaxter, Reliquiae Farlowianae 626 (all NY).

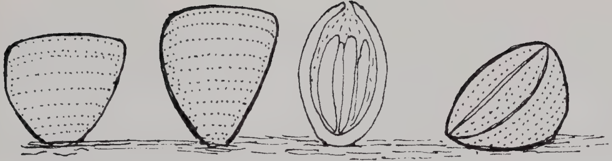
Ostreichnion nova-caesariense (Ellis) Barr, comb. nov.
Figs. 3, 4

Hysterium nova-caesariense Ellis, Bull. Torrey Bot. Club 6: 133. 1877.

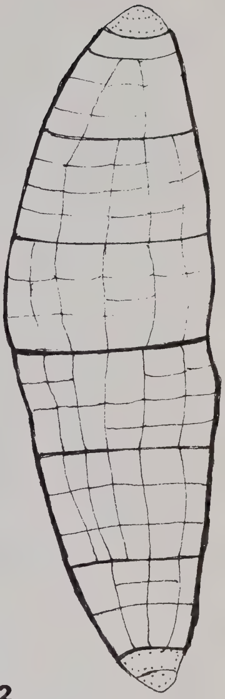
Mytilidion nova-caesariense (Ellis) Rehm, Ascom. n. 313; Sacc. Syll. Fung. 2: 764. 1883.

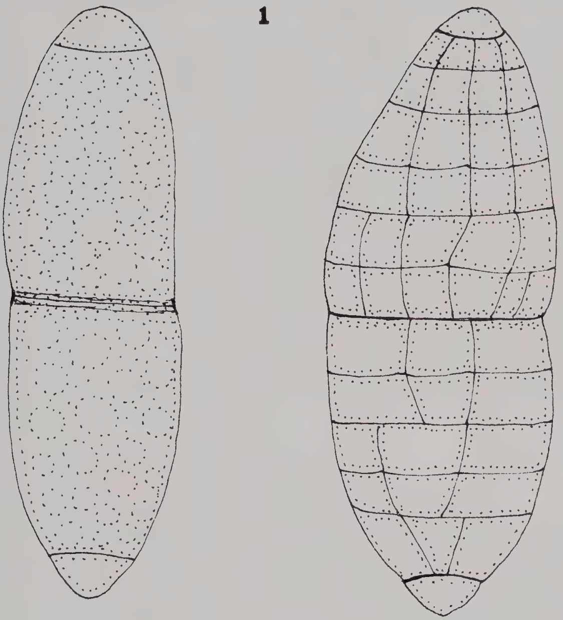
Hysterographium nova-caesariense (Ellis) Roum. Fungi exs. gall. n. 4854; Ell. & Ev. North Amer. Pyreno. p. 702. 1892.

Figs. 1, 2. *Ostreichnion sassafras:* 1. ascocarps, 2. ascospores. Figs. 3, 4. *O. nova-caesariense:* 3. ascocarps, 4. ascospores. Figs. 5, 6. *O. curtisii:* 5. ascocarps, 6. ascospores. Standard line = 1 mm for figures 1, 3, 5; 10 μ for figures 2, 4, 6.

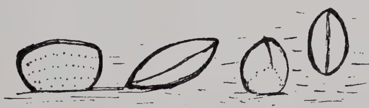


1

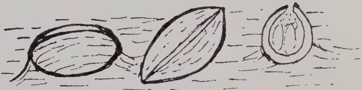




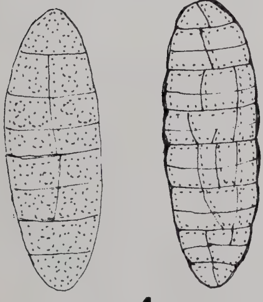
2



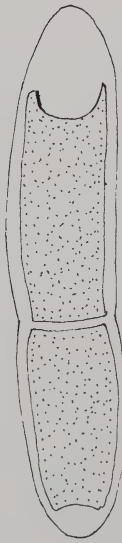
3

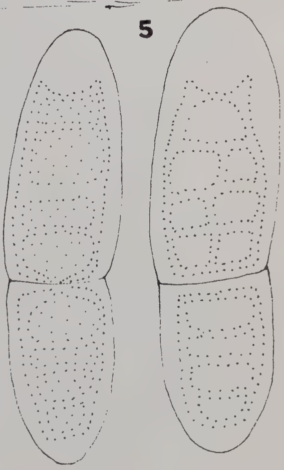


5



4





6

Ascocarps superficial, bases attached to and grown with substrate, elongate and depressed conchate, up to 1 mm long, 275 μ wide and high, surface shining black, faintly horizontally striate, apex compressed along length, depressed, opening by long slit; in section ± globose, peridium brittle prosenchymatous, cells very small, densely encrusted with pigment, narrow, 20-25 μ wide, ± even in width. Asci arising from base, 100-130 x 30-40 μ, oblong-clavate, bitunicate, apex thickened, sessile on foot-like base, 8-spored; pseudoparaphyses narrow, branched and anastomosing, in gel matrix. Ascospores 35-45(-50) x 11-13 μ, dull brown, ± cylindric, tapered to rounded ends, 7-13 transversely septate, not or slightly constricted at septa, 1-3 vertical septa in most cells, usually one into end cells, wall surface smooth.

On bark of *Pinus rigida*, New Jersey.

Material examined: New Jersey: Newfield, J.B. Ellis N.A.F. 152; Newfield, April 1893, Ell.& Ev. Fungi Col. 10 (MASS).

Ostreichnion curtisii (Duby) Barr, comb. nov. Figs. 5, 6

Hysterium curtisii Duby, Mém. Soc. Phys. Hist. Nat. Genève 16: 30. 1862.
Gloniella curtisii (Duby) Sacc. Syll. Fung. 2: 766. 1883.
Hysteroglonium curtisii (Duby) Earle (as Duby in Earle) in Mohr, Contrib. U.S. Nat. Mus. 6: 163. 1901.
Glonium curtisii (Duby) Lohman, Bull. Torrey Bot. Club 64: 66. 1937.
Hysterium cyrillae Berk. & Curt. N.A. Fungi n. 795; Grevillea 4: 11. 1875.
Glonium cyrillae (Berk. & Curt.) Sacc. Syll. Fung. 2: 734. 1883.
Psiloglonium cyrillae (Berk. & Curt.) E. Müller in Müller & von Arx, Beitr. Kryptogamenfl. Schweiz 11(2): 244. 1962.
Hysterium chlorinum Berk. & Curt. N.A. Fungi n. 796; Grevillea 4: 12. 1875.
Glonium chlorinum (Berk. & Curt.) Sacc. Syll. Fung. 2: 734. 1883.
Glonium macrosporium Tracy & Earle, Bull. Torrey Bot. Club 23: 207. 1896.
Glonium gigasporum Ell. & Ev. in Herb. Ellis, ined.

Ascocarps erumpent-superficial, bases attached to and grown with substrate, elongate conchate, 0.5-1 mm or more long, 440-470 μ wide, 330-385 μ high, surface ± shining black, with greenish furfuraceous coating at times, horizontally striate, apex compressed, opening by long slit; in section ± globose, peridium brittle, prosenchymatous, cells small, densely encrusted with pigment, ± even in width throughout, 52-65 μ wide, but subhymenium up to 30 μ thick across base, centrum in section often yellowish under low magnification. Asci arising from base, 150-180(-220) x 25-30(-40) μ, oblong-clavate, bitunicate, apex thickened, with suggestion of refractive ring around cytoplasmic protrusion, base ± sessile and foot-like, 4-8-spored; pseudoparaphyses narrow, branched and anastomosing, in gel matrix which is yellowish granular above asci. Ascospores (45-) 62-82 x (10-)12-15(-17) μ, hyaline, soon light yellowish brown, ± cylindric, ends broadly rounded, 1-septate, septum submedian, slightly constricted, walls thickened especially over upper end to 7-15 μ, cytoplasm contracted and potentially 7- or more septate with vertical division in one or several of cytoplasmic divisions, wall surface smooth.

On woody branches, southeastern United States.

Material examined: South Carolina: H.W. Ravenel, Fungi Car. 48 on *Quercus* (as *Hysterium flexuosum* Schw.) Florida: Green Cove Springs, Winter 1884, G. Martin on *Sabal serru=lata,* Ellis N.A.F. 1321 (as *Hysterium lineolatum* Cke.) Alabama: Tuskegee, Jan 1900, G.W. Carver, on *Vitis rotundifolia* (as *Hysterographium viticolum* Cke. & Peck). (MASS).

Zogg (1962) reported on a collection from Brazil which has the same peculiar ascospores as *O. curtisii* although somewhat smaller, (31-)35-45(-53) x (8-)9-11(-13) μ, and concluded that his Brazilian material was a small variation of *O. curtisii*(as *Glonium*).

Rehm (1886) examined Duby's specimen of *Hysterium curtisii* (on *Vitis,* South Carolina, sent by M.A. Curtis as *Hysterium flexuosum* Schw.) He described the fungus briefly (with ascospore septum above the middle) and noted that it was probably *Gloniella* as Saccardo (1883) had decided. Bisby (1932) studied *Hysterium cyrillae* Berk. & Curt. and *H. chlorinum* Berk. & Curt., noted the submedian position of ascospore septum, and considered both specimens as *Glonium cyrillae.* Lohman (1937) provided a detailed description and illustrations of the species from the type specimen in Duby's collection and from many other collections. No conidial state is known for this or the other species of *Ostreichnion*, either associated in nature or in culture (for *O. curtisii* only).

LITERATURE CITED

Bisby, G.R. 1932. Type specimens of certain Hysteriales. Mycologia 24: 304-329.

Clements, F.E. and C.L. Shear. 1931. The genera of fungi. H.W. Wilson Co., New York. 496 pp.

Darker, G.D. 1963. A new genus of the Lophiaceae. Canad. J. Botany 40: 1383-1388.

Duby, J.E. 1862. Mémoires sur la tribu des Hystérinées de la familie des Hypoxylées (Pyrénomycétes). Mém. Soc. Phys. Hist. Nat. Genéve 16: 15-70.

Lohman, M.L. 1937. Studies in the genus *Glonium* as represented in the Southeast. Bull. Torrey Bot. Club 64: 57-73.

Rehm, H. 1886. Revision der Hysterineen in herb. Duby. Hedwigia 25: 137-155; 173-202.

Rogers, D.P. 1953. Disposition of Nomina Generica Conservanda for Fungi. Taxon 2: 29-32.

Saccardo, P.A. 1883. Sylloge Fungorum, vol. 2. Patavia. 815 + LXIX pp.

Teng, S.C. 1933. Notes on Hysteriales from China. Sinensia 4: 129-144.

Zogg, H. 1962. Die Hysteriaceae s. str. und Lophiaceae. Beitr. Kryptogamenfl. Schweiz 11(3): 1-190.

MYCOTAXON

Vol. III, No. 1, pp. 89-94 October-December 1975

SARCINOSPORON: A NEW GENUS TO ACCOMMODATE *TRICHOSPORON INKIN* AND *PROTOTHECA FILAMENTA*

D. S. KING and S. C. JONG

Mycology Department, American Type Culture Collection
12301 Parklawn Drive, Rockville, Maryland 20852

SUMMARY

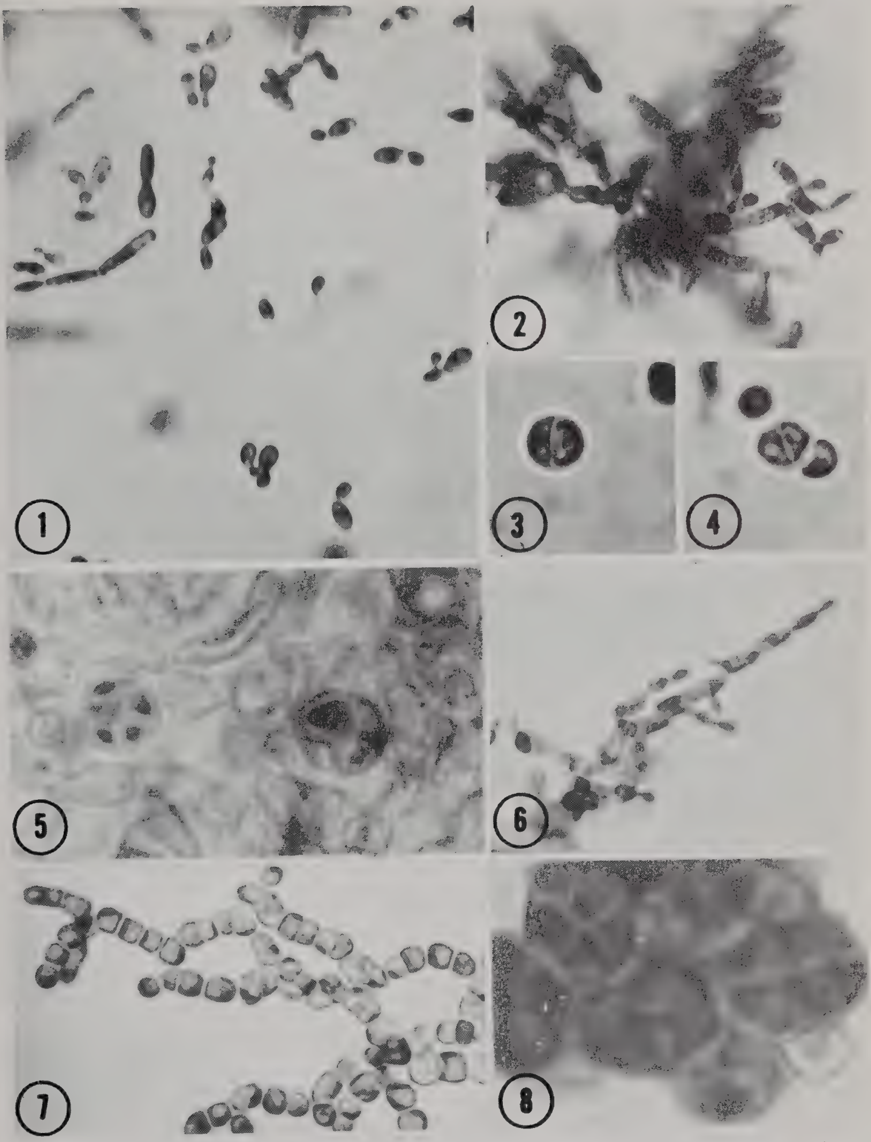
A new genus *Sarcinosporon* and a new combination *S. inkin* are proposed to accommodate *Trichosporon inkin* (Oho) Carmo-Sousa *et* van Uden. *Prototheca filamenta* Arnold *et* Ahearn is considered as a facultative synonym of *S. inkin*. *Sarcinosporon inkin* is characterized by filamentous growth and blastospores budding singly or successively in chains and by the formation of *sarcina*-like agglomerates of endospores in sporangia formed by individual blastospores or by septation of filaments in different planes.

Sarcinomyces inkin Oho (1919) was first isolated and described from skin scrapings of a scrotal dermatosis frequently found in young males in Formosa. It was characterized by filamentous growth along with the formation of clusters of cells by septation in different planes. Mesones and Dodge (1960) reported on two additional cultures of this organism isolated by them from scrotal lesions of two Peruvian young males in Brasil and described some of their physiological characters. Carmo-Sousa and van Uden (1967) studied a culture isolated in 1957 from a case of "tinea cruris" caused by *Trichophyton tonsurans* Malmsten in a Portugese woman. They considered this culture to be morphologically and physiologically identical with those described by Oho and by Mesones and Dodge. However, they regarded some of the structures observed to be blastospores and arthrospores and transferred *S. inkin* to the genus *Trichosporon* Behrend. Since the cultures studied by the previous workers were lost, Carmo-Sousa and van Uden's isolate (ATCC 18020 = CBS 5585) was designated by them as the type of *T. inkin* (Oho) Carmo-Sousa *et* van Uden. Subsequently Hedrick and Dupont (1968) and Carmo-Sousa (1970) accepted this species in *Trichosporon*.

We are currently investigating the systematics of the genus *Trichosporon* and have consequently examined the type strain of *T. inkin* ATCC 18020. We grew this strain on 6 different media, including glucose-yeast extract-peptone and cornmeal agars as described by Carmo-Sousa and van Uden, and observed blastospores (budding cells) in both the filamentous phase and the unicellular phase (Fig. 1). Although we observed septation of filaments and breakdown of the other filaments beyond the stage that the segments could reasonably be considered to function as spores, we were unable to observe arthrospores. On glucose-yeast extract-peptone and Harrold's M40Y (malt extract, 2%; yeast extract, 0.5%; sucrose, 50%; agar, 2%) agars we also observed the production of endospores by internal cleavage in several planes similar to those described for *Prototheca filamenta* Arnold *et* Ahearn (1972) (Fig. 4).

Prototheca filamenta was isolated from human skin in Cleveland, Ohio, and described as a new species of colorless alga. In addition to production of the sporangia that produce several endospores typical of *Prototheca* Krüger (1894), *P. filamenta* is morphologically distinct in that it produces filamentous growth on cornmeal agar reminiscent of that reported for *T. inkin* (Fig. 2,6). Arnold and Ahearn also investigated physiological properties of the genus, and provided a physiological key to the species of *Prototheca* recognized by them.

Comparison of the type strains of *T. inkin* ATCC 18020 and *P. filamenta* ATCC 22432 revealed many striking similarities and few differences. Both strains were isolated from humans. In macroscopic appearance both are dry, friable, and cream to brownish in old agar cultures, with a raised center and radiating furrows. Morphologically, both strains produce filamentous growth that becomes septate (Fig. 7), more-or-less globular groups of cells that divide by septation in several planes (Fig. 4,8), and filaments that produce blastospores (Fig. 2,6). The groups of cells that divide by septation are actually sporangia,



Figs. 1-5. *Trichosporon inkin* ATCC 18020. 1. Unicellular budding phase and elongate segments with truncated ends. *ca*. X 675. 2. Filaments of elongate blastospores resembling pseudomycelia. *ca*. X 675. 3. Two-spored sporangium. *ca*. X 1500. 4. Three-spored sporangium. *ca*. X 1500. 5. Multiple-spored sporangia in an old culture. *ca*. X 1500. Figs. 6-8. *Prototheca filamenta* ATCC 22432. 6. Filaments of elongate blastospores resembling pseudomycelia. *ca*. X 675. 7. Septate filaments. *ca*. X 675. 8. Multiple-spored sporangia. *ca*. X 1500.

and both strains also produce a unicellular budding phase. Filamentous growth and the unicellular budding phase are both produced on cornmeal agar after two days at room temperature (*ca.* 24 C).

The differences are quantitative in nature. ATCC 18020 produces more abundantly the single cell budding phase and more blastospores in chains than ATCC 22432, while the latter produces sporangia and chains of sporangia more abundantly than does ATCC 18020. Also, the sporangia of ATCC 18020 appear to release their endospores more quickly and thus they are scarce in older cultures. Both strains produce chlamydospores by thickening of cell walls in single cells and in endospores retained in sporangia (Fig. 5). ATCC 18020 produces mainly 2-spored sporangia (Fig. 3), while ATCC 22432 produces multiple-spored sporangia in abundance.

Comparing our results for ATCC 18020 with the results reported by Arnold and Ahearn for ATCC 22432, both strains utilize glucose, sucrose, maltose, lactose, galactose, cellobiose, xylose, trehalose, and ethanol. They grow at 25-37 C and fail to grow at 45 C or on vitamin-free media. They are both urease positive, although Carmo-Sousa (1970) reported ATCC 18020 to be urease negative. The only difference was the utilization of dulcitol by ATCC 22432 and not by ATCC 18020. According to the key of Arnold and Ahearn (1972), ATCC 18020 is referable to *P. filamenta*. We consider the differences between ATCC 22432 and ATCC 18020 to be significant only at the strain level and not at the specific level.

We are convinced that both strains represent the same species, but not that they belong in *Prototheca*. Filamentous growth and formation of blastospores (budding cells) are clearly excluded from the generic concept of *Prototheca* as given by Cooke (1968) and Tubaki and Soneda (1959). We therefore propose the following new genus and combination:

SARCINOSPORON King *et* Jong, *gen. nov.*

Cultura in agarico farinacea, albida vel brunneola. Cellulae vegetativae filamentosae vel gemmiparae. Fibrae septatae, sporangiferae et blastosporiferae. Sporangiolae sarciniformibae, e una vel duobus vel plures endosporae constata. Endosporae schizogenae membrana et tunica communi obvolutae, dein liberatae. Sexsporae nullae.

Typus: Sarcinomyces inkin Oho

Sarcinosporon inkin (Oho) King *et* Jong, *comb. nov.*

≡ *Sarcinomyces inkin* Oho, Kyoto Igaku Zasshi *16:* 15. 1919.

≡ *Trichosporon inkin* (Oho) Carmo-Sousa *et* van Uden, Mycologia *59:* 653. 1967.

= *Prototheca filamenta* Arnold *et* Ahearn, Mycologia *64:* 270. 1972.

Colonies dry, friable, and cream to brownish in old agar cultures, with a raised center and radiating furrows. Vegetative cells unicellular or filamentous with true septa, multiplying by budding singly or successively in chains. Sporangia formed by septation in different planes of individual blastospores or of cells in filaments, *sarcina*-like, 4.5 - 13.4 x 5.4 - 16.1 µ, containing one to several endospores at maturity. Endospores ovoid or ellipsoid, 1.3 - 6.3 x 1.3 - 9.0 µ, walls of endospores thin, becoming visible upon disintegration of the sporangium wall. Some cells and endospores within sporangia producing chlamydospores by developing a thick, smooth wall. No plastid-like structures observed. No sexual reproduction observed.

Physiology as reported by Carmo-Sousa (1970) except dulcitol + or -. Urease reaction positive as reported by Arnold and Ahearn (1972).

The method of endospore production allies this organism to the algae, but its heterotrophism, filamentous growth and reproduction by budding are fungal in nature.

The type strain ATCC 18020 is preserved by being frozen and stored in liquid nitrogen at -196 C at the ATCC. The holotype, a dried cornmeal agar plate culture of this strain, has been deposited in the herbarium of the National Fungus Collections, Beltsville, Maryland.

ACKNOWLEDGMENTS

We would like to thank Dr. Lekh R. Batra for his review of the manuscript. This work was supported in part by National Science Foundation Grant BMS 75-06286 and Brown-Hazen Grant BH 846 from Research Corporation, New York.

LITERATURE CITED

ARNOLD, P., and D. G. AHEARN. 1972. The systematics of the genus *Prototheca* with a description of a new species *P. filamenta*. Mycologia *64:* 265-275.

CARMO-SOUSA, L. DO. 1970. *Trichosporon* Behrend. *In* J. Lodder (Ed.), The Yeasts. North-Holland Publishing Co., Amsterdam, p. 1309-1352.

__________ and N. VAN UDEN. 1967. Reisolation of *Sarcinomyces inkin* and its transfer to the genus *Trichosporon*. Mycologia *59:* 653-657.

COOKE, W. B. 1968. Studies in the genus *Prototheca*. II. Taxonomy. J. Elisha Mitchell Sci. Soc. *84:* 217-220.

HEDRICK, L. R. and P. D. DUPONT. 1968. The utilization of L-amino acids as carbon source by yeasts of the genera *Hansenula* and *Trichosporon*. Antonie van Leeuwenhoek *34:* 465-473.

KRÜGER, W. 1894. Kurz Characteristik einiger niederen Organismen in Saftflüsse de Laubbäume. 1. Uber einen neuen Pilz-typus, repräsentiert durch die Gattung *Prototheca (Pr. moriformis et Pr. Zopfi)*. Hedwigia *33:* 241-251.

MESONES, H. A. and C. W. DODGE. 1960. *Sarcinomyces inkin* in Brasil. Mycologia *52:* 800-804.

OHO, O. 1919. Ueber das sogenannte "Inkin." Kyoto Ingaku Zasshi *16:* 7-21.

TUBAKI, K. and M. SONEDA. 1959. Cultural and taxonomical studies on *Prototheca*. Nagaoa *1959:* 25-34.

MYCOTAXON

Vol. III, No. 1, pp. 95-101 October-December 1975

CORTINARIUS, SECTION DERMOCYBE—CORTINARIUS CLELANDII

JOSEPH F. AMMIRATI[1]

Mycology Laboratory, Plant Protection Institute
Agricultural Research Service, U.S. Dept. of Agriculture
Beltsville, Maryland 20705

SUMMARY

A lectotype is chosen for *Cortinarius clelandii* Smith. A description of the lectotype is accompanied by photomicrographs showing the nature of the basidiospore ornamentation, including the reduced size of ornamentation in the suprahilar region.

Cortinarius clelandii Smith (1944) was published as a *nomen novum* for *C. subcinnamomeus* Cleland (1928), because *C. subcinnamomeus* Karsten (1889) antedated Cleland's use of the species epithet in *Cortinarius*. Smith (1935) reported *C. clelandii* (as *C. subcinnamomeus*) from North America, but his specimens were later found to differ from Cleland's species and were the basis for description of a new species, *C. tubarius* Ammirati & Smith (Mich. Bot. 11: 22-24. 1972).

To gain a clearer understanding of *C. clelandii*, I obtained two collections from the Waite Agricultural Research Institute (ADW) in Adelaide, South Australia, and also studied a collection on deposit at the National Fungus Collections (BPI) in Beltsville, Maryland. All three collections were made and identified by J. B. Cleland and were from Mt. Lofty, South Australia. The collection at the National Fungus Collections (BPI 70684), labeled "cotype", was received from Cleland on September 18, 1930. The two collections from the Waite Agricultural Research

---

[1] Present address: Erindale College, University of Toronto, Mississauga, Ontario L5L 1C6, Canada.

Institute are numbered ADW 15118 and ADW 15119.

Cleland's original notes on the fresh basidiocarps and microscopic characters are included with collection ADW 15118. The close correlation between these notes and the original description of *C. clelandii* indicates that this collection is the one from which he described the species. A notation in the original description that the species was painted by an artist (Miss Fiveash) is confirmed by the same notation with collection ADW 15118.

When I studied each basidiocarp and the fragments in collection ADW 15118, I found that the microscopic characteristics of all the elements of the collection were similar, except those of half of a basidiocarp. The discordant element of the collection was separated easily by its longer spores, 9.6-12(-12.8) µm, average 11.0 µm, and by the abundance of large interhyphal pigment deposits in the pileus and lamellar trama. It was removed from collection ADW 15118 and designated as ADW 15118a. Because Cleland did not designate a holotype, collection ADW 15118 is selected as the lectotype for *C. clelandii* Smith (synonym: *Cortinarius subcinnamomeus* Cleland, Trans. & Proc. Roy. Soc. South Australia 52: 220-221. 1928).

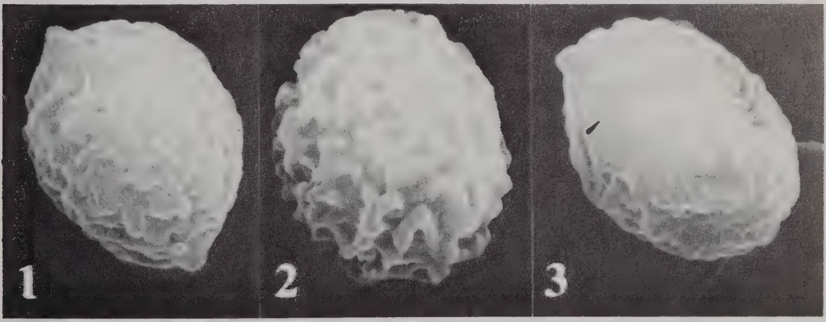
Collection ADW 15119 also contained two elements. Most of the basidiocarps had microscopic characteristics similar to those of the specimen designated above as ADW 15118a. However, two basidiocarps were totally unrelated and not members of the section *Dermocybe*. These were separated from collection ADW 15119 and designated as ADW 15119a. They have not been determined to species. Collection BPI 70684 contains three specimens, all microscopically similar to collections ADW 15118a and ADW 15119 and different from ADW 15118.

Collections ADW 15118a, ADW 15119, and BPI 70684 significantly differ from the lectotype (ADW 15118). Without notes on the fresh condition of the basidiocarps, they cannot be correctly determined. Also, further studies of fresh specimens are needed before the range of variation in *C. clelandii* can be determined.

Cleland (1928), in his discussion of *C. clelandii*, noted variation among his collections, especially in the color of the fresh basidiocarps and the spore size; however, he later (1934) combined these elements in one composite description. In such a difficult group as *Dermocybe*, it is not surprising to find mixed (heterogeneous) and misidentified collections, especially among those made in the early part of this century, when microscopic characteristics and chemical reactions received little or no attention. For example, in America then, such species as *C. tubarius*, *C. huronensis* Ammirati & Smith, and *C. incognitus* Ammirati & Smith were all placed in *C. cinnamomeus* (Fries) S. F. Gray.

Following is a description of *C. clelandii* based on the lectotype. The macroscopic characteristics presented are taken from Cleland's original description. These are followed by his observations on the basidiospores. Finally, I have described the microscopic characteristics and chemical color reactions of the lectotype. The microscopic observations were made from sections and pieces of basidiocarp mounted in 3% KOH, unless otherwise noted. The capitalized color terms are from Ridgway (1912). Color names in parentheses, which I have added, follow the terminology of Kelly and Judd (1955).

Photomicrographs of the basidiospores of the lectotype as viewed with a scanning electron microscope are included to show the nature of the spore ornamentation (Figs. 1-3). Of particular interest is the reduced size of the ornamentation in the suprahilar region of the spore (Fig. 3). This is seen with a compound microscope (oil immersion,



Figures 1-3. *Cortinarius clelandii*. Scanning electron micrographs of basidiospores, X5000. 1-2. Spore ornamentation. 3. Reduced size of ornamentation in the suprahilar region (arrow).

900X) as a flattened and less coarsely ornamented region. A scanning electron microscope preparation of the basidiospores (a 300-angstrom coating, palladium 40%, gold 60%) of the lectotype is on deposit with the specimens at the Waite Agricultural Research Institute.

Cortinarius clelandii Smith, Lloydia 7(3): 203. 1944.

Figs. 1-5

PILEUS up to 6.2 cm broad, convex, gibbous, then expanding, the margin slightly upturned and wavy, minutely fibrillose, when young Saccardo's Umber (near dull deep yellowish brown), then near Snuff Brown (moderate brown to deep brown) passing into Bister (dark yellowish brown) in the center, later Burnt Umber (near moderate reddish brown), becoming nearly black in the center.

LAMELLAE sinuate, moderately close, 10 mm deep, when young Mustard Yellow (brilliant yellow), becoming Buckthorn Brown (strong yellowish brown).

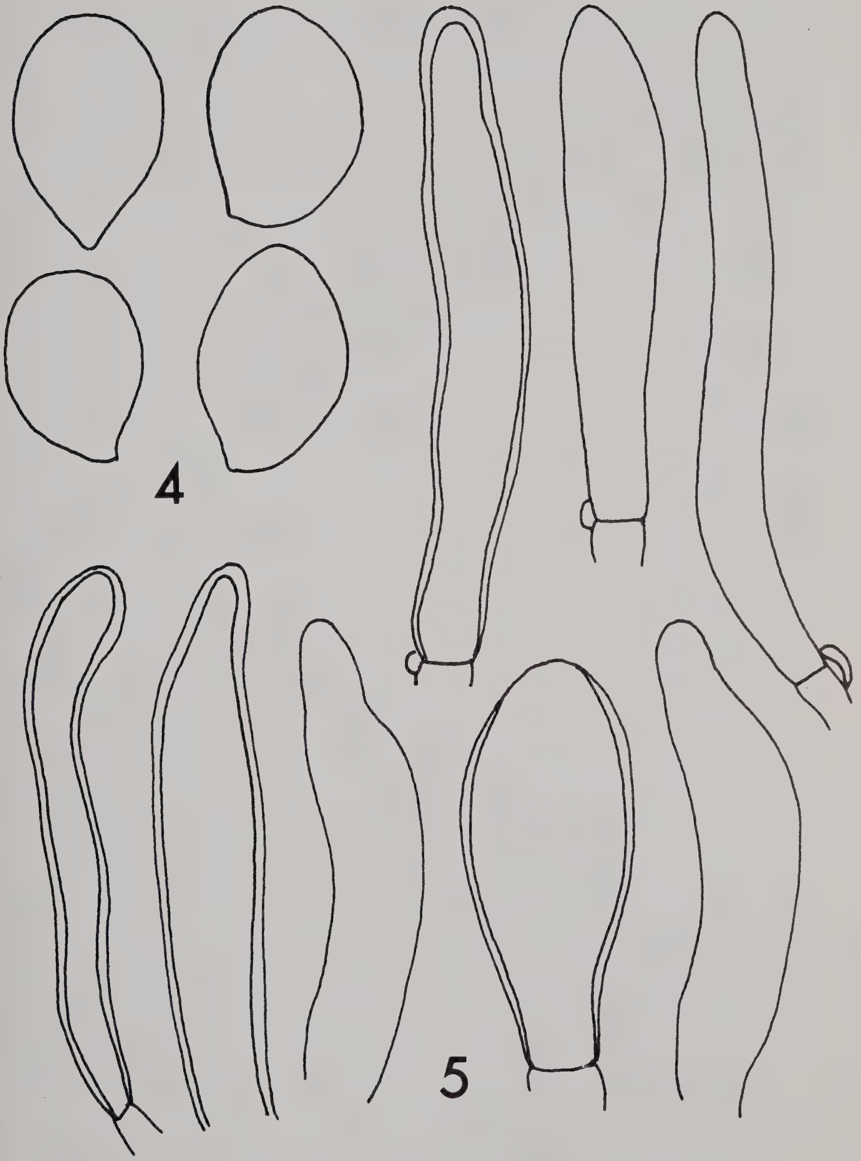
STIPE up to 7.5 cm long, 6-12.5 mm thick, slender or stout, slightly bulbous, somewhat fibrillose and striate, with tints of Naples Yellow (light yellow), markedly hollow.

FLESH yellowish, heaped up under the umbo, gradually attenuated outwards.

COBWEB VEIL (Cortina) pale yellowish.

SPORES (as described by Cleland, 1928) irregularly elliptical, slightly rough, yellowish brown, 10.5 X 6.5 µm.

SPORES 8.8-10.4 X 6.4-8(-8.8) µm, average length 9.7 µm, average width 7.2 µm, in profile inequilateral, general outline mostly broadly ellipsoid, sometimes ellipsoid or subglobose, in face view broadly ellipsoid to broadly fusoid, light to moderate yellowish brown, ornamentation darker brown, verrucose to rugulose (Figs. 1-3), ornamentation medium to coarse, sometimes coarser toward the distal end, reduced in size in the suprahilar region (Fig. 3). BASIDIA 24-36 X 8-10 µm, 4-spored, broadly clavate to narrowly clavate, sometimes slightly ventricose to irregular in outline, hyaline or containing a diffuse pale purplish to pale red purple pigment, usually containing particles or masses of purplish to red purple pigment, which may fade to paler or hyaline on standing, clamp connections present. BASIDIOLES 17.6-32 X 7.6-9.6 µm, shaped like the basidia or more narrowly clavate (primordial elements not included), color and contents as for basidia. PLEUROCYSTIDIA absent. CHEILOCYSTIDIA apparently absent (lamellar edges not easily revived, and many damaged). LAMELLAR TRAMA of subparallel



Figures 4-5. *Cortinarius clelandii*. 4. Outline drawings of basidiospores (ornamentation omitted), X2675. 5. Hyphal end cells from pileus cuticle, X1100.

and somewhat interwoven hyphae 6-24 µm wide, which are cylindrical to more or less inflated, hyaline to slightly colored or containing a diffuse pale purplish to pale red purple pigment, sometimes containing particles and masses of purplish to red purple pigment, clamp connections present. SUBHYMENIUM of interwoven, cylindrical hyphae 2.4-4.4 µm wide, color and contents as for the hyphae of the lamellar trama, clamp connections present. PILEUS CUTICLE of interwoven, more or less radially arranged hyphae (4-) 8.8-21.6(-30.4) µm wide, which are cylindrical to more or less inflated, with walls up to 1.4 µm thick, often incrusted with brownish pigment (best observed in H_2O mounts, because KOH tends to dissolve the incrustations), pale brownish to slightly paler or occasionally with a diffuse red purple pigment, clamp connections present; end cells of cuticular hyphae somewhat variable in shape, mostly with rounded to tapered apices, some slightly upturned but apparently not forming a layer of upturned hyphal end cells, walls brownish, contents as in other cuticular hyphae, walls up to 1.4 µm thick, some incrusted. PILEUS TRAMA of interwoven hyphae (6-)7.2-25.6(-32) µm, which are somewhat radially arranged in the upper trama, less so in the lower trama, cylindrical to inflated, pale yellowish or pinkish or nearly hyaline, clamp connections present. STIPE SURFACE of subparallel, somewhat interwoven hyphae 5.6-24 µm wide, cylindrical to somewhat inflated, hyaline or pinkish to pale reddish, clamp connections present; caulocystidia apparently absent. OLEIFEROUS HYPHAE observed in the pileus and lamellar trama, refractive and hyaline or pale yellowish. INTERHYPHAL PIGMENT DEPOSITS apparently uncommon, only observed in pileus trama beneath the cuticle, reddish; small interhyphal particles of purplish to red purple pigment observed in the lamellar trama, larger deposits apparently lacking.

The pileus surface and lamellae of dried specimens turn dull dark red with the application of KOH.

Gregarious, Mt. Lofty, South Australia, collected by J. Burton Cleland, June 1921.

The author thanks Dr. P. H. B. Talbot and the Waite Agricultural Research Institute for the loan of collections of *C. clelandii* and Mrs. Flora G. Pollack and Dr. Martina S. Gilliam for their valuable comments.

LITERATURE CITED

Cleland, J. B. 1928. Australian fungi: notes and descriptions. No. 7. Trans. & Proc. Roy. Soc. South Australia 52: 217-222.

————— . 1934. Toadstools and mushrooms and other larger fungi of South Australia. Part I. Harrison Weir, Government Printer, Adelaide, South Australia. 178 p.

Kelly, K. L., & D. B. Judd. 1955. The ISCC-NBS method of designating colors and a dictionary of color names. Nat. Bur. Standards Circ. 553. U.S. Government Printing Office, Washington, D.C. 158 p.

Ridgway, R. 1912. Color standards and color nomenclature. Published by the author, Washington, D.C. 43 p.

Smith, A. H. 1935. Unusual agarics from Michigan. II. Pap. Michigan Acad. Sci. 20: 171-183.

—————. 1944. New and interesting *Cortinarii* from North America. Lloydia 7(3): 163-235.

MYCOTAXON

Vol. III, No. 1, pp. 102-104 October-December 1975

PHYSCIA DUPLICORTICATA WEBER & THOMSON SP. NOV. FROM CALIFORNIA

WILLIAM A. WEBER

University of Colorado Museum, Boulder, Colorado 80302

AND

JOHN W. THOMSON

Dept. of Botany, University of Wisconsin
Madison, Wisconsin 53706

Preliminary to distribution of isotypes of a new species of *Physcia* from California in Lichenes Exsiccati issued by the University of Colorado this species should be described in the literature.

PHYSCIA DUPLICORTICATA W. A. Weber & Thomson sp. nov.

Descriptio typi:

Thallus tenuis, 0.2-1.5 mm crassus, membranaceus, sat laxe adnatus, virido-cinereus, laevigatus, laciniis adscendentibus, flexuosis, apices versus latioribus, ad 2.0 mm latis, margines versus minute lobatis granulosis et labriforme livorediosis, extus K+ lutescens, intus K-, extus et intus C-, P-, I-, subtus albidus, parce rhizinosus, rhizinis albidis. Apothecia sparsa, sessilia, ad 1 mm lata, epruinosa, rufescentia, marginibus crassis, inflexis, thallo concoloribus, leviter crenulatis. Pycnoconidangia sparsa, minuta, immersa, rufescentia, pycnoconidia bacilliformia, recta, 4-5 x 1 μ.

Stratum corticale superius thalli 30-70 μ crassum, incoloratum, paraplectenchymaticum, cellulis ± rotundatis, diam 10-12 μ; stratum algarum ca 70 μ crassum; algae ad Trebouxiae pertinentes, diam 5-15 μ; stratum medullare ex hyphis implexis, diam 5-6 μ, ad parte exteriore ± paral-

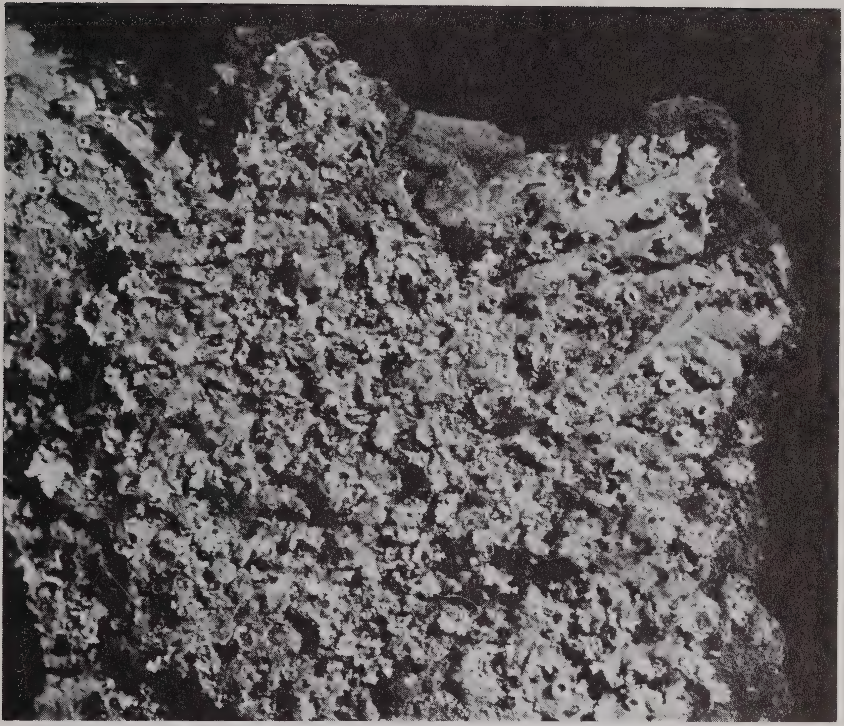


Figure 1. *Physcia duplicorticata* Weber & Thomson, n. sp., type specimen (COLO).

lelis; stratum corticale inferius paraplectenchymaticum, crassum, 50 µ.

Amphithecium subtus cortice crasso, incolorato, paraplectenchymatico, cellulis fere ut in strato corticale superius thalli, strato interiore laxo, algis repleto. Parathecium distinctum, tenue. Hypothecium incoloratum, 60 µ, hymenium 150 µ, parte superiore 15 µ fuscescens, paraphyses cohaerentes, incoloratae, 1.5 µ crassae, asci clavati 15 x 80 µ, sporae distichae, obscuratae, 1-septatae, oblongae, non constrictae, rectae vel leviter curvatae, 7-10 x 18-20 µ, episporio ± aequaliter incrassato.

Type: On *Umbellularia*, east of junction of Nicasio road and Point Reyes road, Marin Co., Calif., 12 March 1975, W. A. Weber & Greg Kunkel. Type in herb. COLO, isotypes distributed in Lich. Exsicc. COLO No. 476. Figure 1.

This species very much resembles *Physcia millegrana* Degel. and like that, belongs in the Group Tribacia (Lynge) Thomson. It appears as a slightly coarser plant with thicker thallus with the internal tissues correspondingly thicker, the upper cortex 70 µ *versus* 45 µ, the entire thallus being only about 100 µ thick in *P. millegrana*. The lower cortex is markedly paraplectenchymatous and sharply differentiated *versus* blending into the medulla with at most a single layer of superficial paraplectenchymatous-appearing cells in *P. millegrana*. The apothecia are epruinose and brown-red *versus* very blue pruinose over a black ground color in *P. millegrana*. The marginal granules on the lobes have more the appearance of minute lobules than in *P. millegrana* in which they are more granular to isidioid-granular, and are coarser than in *P. millegrana*. They also may be formed on the underside of the margins of the lobes. *Physcia tribacia* is somewhat similar in the formation of the lower cortex but does not form the labriform soralia in addition to the marginal granules.

The name is chosen in allusion to the character differentiating the new species from *P. millegrana*.

Extracts of *P. duplicorticata* yielded atranorin, no zeorin, in MC tests.

An additional specimen of this species is in WIS: On *Cupressus macrocarpa*, S end of San Andreas Lake, San Francisco Watershed, San Mateo Co., Calif., 13 Sept. 1967, Wm. Jordan 756-B. We interpret the new species as an endemic of the fog belt of the San Francisco Bay region.

MYCOTAXON

Vol. III, No. 1, pp. 105-108 October-December 1975

SCANNING ELECTRON MICROGRAPHS OF ASCOSPORES OF *PACHYELLA* (DISCOMYCETES)

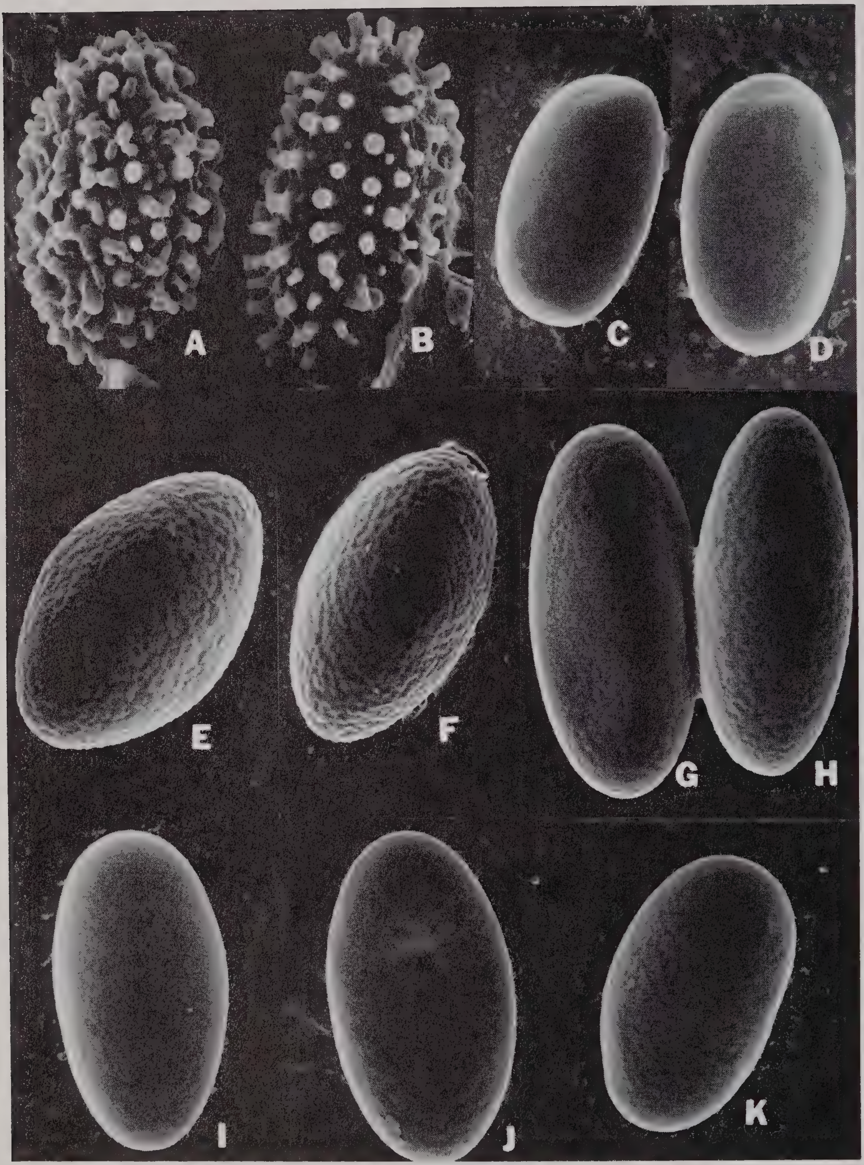
DONALD H. PFISTER

The Farlow Reference Library and Herbarium of Cryptogamic
Botany and the Biology Department,
Harvard University, Cambridge, MA 02138

In the recognition and delimitation of species in the family Pezizaceae *sensu stricto* wall ornamentations are important features. The production of episporal wall material in the Pezizales and the form of its deposition have been studied thoroughly by Le Gal (1947). With few exceptions, most notably Le Gal's work in the family, attempts to illustrate wall ornamentations by camera lucida or freehand drawings have failed to provide detailed and accurate representations. Recently Elliott and Kaufert (1974) have shown that spore differences in this family are accurately depicted using scanning electron photomicrographs. Two species of *Peziza* were studied in their work. In *Peziza* there is a great variety of ascospore ornamentation types. To a lesser extent these types are paralleled in the small, segregate genus *Pachyella*, the subject of this paper.

The genus *Pachyella* has been monographed by Pfister (1973). The species are well delimited by apothecial size and morphology, hymenial color, geographical range and ascospore ornamentation. With ample material of all but one of the six species, and scanning electron microscope facilities available, it was possible to photograph ascospores at 5,000x and compare these with the previously published camera lucida drawings (Pfister, 1973). These photographs are reproduced in fig. 1.

For the most part, these studies verify the earlier interpretations. The ornamentations of the grossly warted *P. adnata* (Berk. & Curt.) Pfist. are comparable in both the camera lucida drawings (see Pfister 1973, fig. 1, *d-f*) and the SEM photographs (fig 1, A and B). However, the two species with finely sculptured ascospores, *P. violaceonigra* (Rehm) Pfist. and *P. punctispora* Pfist., are shown


A
B
C
D
E
F
G
H
I
J
K

more accurately here than previously (see Pfister 1973, fig. 1, *g*-*i* and fig. 5, *b*-*d*).

The ornamentations in *P. violaceonigra* are dense and sometimes form low ridges through anastomosis of the warts (fig. 1, G, H, and K). Unfortunately material of *P. megalosperma* (Le Gal) Pfist., a species which has similar though more highly ornamented ascospores, was not available for study. The ornamentations of *P. punctispora* are also denser than previously shown (fig. 1, E and F). In both *P. punctispora* and *P. violaceonigra* the spores have definite raised warts. The two species are easily distinguished otherwise by their characteristic apothecial tissue organizations.

Pachyella babingtonii (Berk. & Br.) Boud. (see Pfister 1973, fig. 2, *a*-*e*) and *P. clypeata* (Schw.) Le Gal (see Pfister 1973, fig. 1, *a*-*c*), both drawn with smooth spores, are smooth-spored even at these higher magnifications. In several collections of *P. babingtonii* examined earlier there was evidence of markings. Such markings appear infrequently in this species and were not seen in this collection (fig. 1, C and D). The spore surface of *P. clypeata*, though lacking any particular organized marking, sometimes appears to be wavy or undulating (fig. 1, I and J).

These comparative studies reinforce the position taken on species delimitation in this genus. The inclusion of the photographs will supplement the illustrations presented in the monograph of the genus.

Fig. 1 (A-K). Ascospores of *Pachyella* species photographed x5,000. A and B, *P. adnata*. C and D, *P. babingtonii*. E and F, *P. punctispora*. G, H, and K, *P. violaceonigra*. I and J, *P. clypeata*.

I was aided in the preparation and observation of this material by Ed Seling of the Scanning Electron Microscope Laboratory of the Museum of Comparative Zoology of Harvard University and by Glenda Winn of the Farlow Herbarium, both of whom I wish to thank.

Literature Cited

Elliott, M. E., and M. Kaufert. 1974. *Peziza badia* and *Peziza badio-confusa.* Canad. J. Botan. 52:467-472.

Le Gal, M. 1947. Recherches sur les ornementations sporales des discomycètes operculés. Ann. Sci. Nat. Bot. XI *8*:73-297.

Pfister, D. H. 1973. The psilpezioid fungi. *IV*. The genus *Pachyella* (Pezizales). Canad. J. Botan. *51*:2009-2023.

MYCOTAXON

Vol. III, No. 1, pp. 109-118 October-December 1975

ELECTROPHORETIC CHARACTERISTICS OF ENZYMES AS A TAXONOMIC CRITERION IN THE GENUS HUMICOLA

J. Moorhouse and M. de Bertoldi °

Department of Genetics, University of Birmingham, P.O. Box 363, Birmingham B15 2TT, England.

SUMMARY

Twenty-seven strains of *Humicola* were examined for the presence of variant isoenzymes of α and β esterase, acid and alkaline phosphatase, leucine amino peptidase and peroxidase. The strains studied included six species of *Humicola* and many unclassified strains. With only one exception the unclassified strains differed significantly from the type species, and were considered to belong to different species. Certain pairs if unclassified strains were very similar, showing the genetical similarity which exists between these strains.

INTRODUCTION

In a previous work, several new strains of *Humicola* have been described (de Bertoldi, Lepidi and Nuti, 1972) and a classification on the basis of DNA base composition attempted (Lepidi, Nuti, de Bertoldi and Santulli, 1972; de Bertoldi, Lepidi and Nuti, 1973). Because of the spontaneous variation in morphology that occours among these strains, classification only on morphological grounds is of doubtful value. Furthermore, no clear correlation is found between the DNA base composition (GC%) of these strains and the morphological characters used for their classification.

In order to clarify the biochemical reletionships between the new strains and the species previously described, their enzyme variation was studied using electrophoretic techniques. This method has been applied to many other fungal genera (for example see Nealson and Garber 1967, Reddy and

---

° Present address: Istituto Microbiologia Agraria, University of Pisa, Centro di Studio per la Microbiologia del Suolo del C.N.R., Pisa, Italy.

Threlkeld 1971, Wong and Willetts 1973), and has been shown to be an useful aid to their taxonomy. The study of enzyme variation is more discriminating than gross morphology and GC%, because similarities for these latter characters can be produced by markedly different genomes, whereas when zymograms for several different enzymes are compared, similarities must be due to genetical similarities.

MATERIALS AND METHODS

Strains. The strains and their origins are described in Table 1. Those in the culture collection of the Istituto di Microbiologia Agraria, Pisa, have been described previously (de Bertoldi *et al.*,1972).

Culture conditions. Strains were grown for enzyme extraction in 100 ml of liquid minimal medium (Pontecorvo *et al.* 1953) supplemented with 2% yeast extract and 2% sucrose in 250 ml Erlenmeyer flasks to which 0.5 gm carborundum (320 mesh) was added before sterilisation. These cultures were grown at 26°C for 4-6 days on a rotatory shaker.

Preparation of Extracts. This was performed at 4°C. Mycelium mixed with carborundum was harvested by filtration and blotted dry with absorbent paper. The mixture was ground in a pre-cooled pestle and mortar and after centrifugation, the crude extract was deep frozen until use. Three flasks were grown for each strain, and the mycelium from these combined before extraction. Each strain was also grown on two occasions to provide replicate extracts.

Electrophoresis. Starch gel electrophoresis was carried out on the extracts using the horizontal method described by Brewbaker, Upadhya, Makinen and Macdonald (1968) using their modification of the buffer system of Ashton and Braden (1961) for the separation of the enzymes α-Esterase (α-Est), β-Esterase (β-Est) and Leucine amino peptidase (L.A.P.). A sodium hydroxide-boric acid buffer system (System II - Shaw and Prasad 1970) was used for the enzymes peroxidase (Apx), acid phosphatase (Pac) and alkaline phosphatase (Pal).

Staining methods. After electrophoresis the starch gels were sliced and stained for enzymic activity by overnight immersion in one of the following mixtures: α-Est: 100 ml 0.1 M phosphate buffer pH 6.0, 2 ml α-napthyl acetate (1% in 50:50 acetone:water) and 30 mg Fast Garnet G.B.C. (Gurrs); β-Est: as for α but using β-napthyl acetate; L.A.P.: 40 mg L. leucyl β-napthyl-amide HCl dissolved in 5 ml dimethyl formamide, 100 ml 0.1 M phosphate buffer pH 6.0 and 50 mg Blak K salt (Gurrs); Apx: 50 mg 3-amino, 9-ethyl carbazole dissolved in 5 ml dimethyl formamide, 100 ml 0;05 M sodium acetate buffer pH 5.0 and 0.5 ml 30 vol. hydrogen peroxide;

Pac: 100 ml 0.5 M sodium acetate buffer pH 5.0, 25 mg sodium α-napthyl phosphate and 100 mg Fast Red T.R.N. (Gurrs); Pal: as Pac but the buffer replaced by water.

Table 1. List of *Humicola* strains studied and their source.

ORGANISMS	ABBREV-IATION	SOURCE[°]
Humicola grisea Traaen	GR	CBS 112.12
H. fuscoatra Traaen	FU	CBS 118.14
H. alopallonella Meyer & Moore	AL	CBS 207.60
H. brunnea Fassatiovà	BR	CBS 217.38
H. brunnea Fassatiovà	EA3	CCFP
H. brunnea v.*africana* Fassatiovà	EA4	CCFP
H. parvispora Gambogi	G5	IMAP
Humicola sp	20-31	IMAP
" "	20-31W	spont.white variant from 20-31
" "	20-31B	spont.black variant from 20-31
" "	20-31P	spont.brown variant from 20-31
" "	HT	IMAP
" "	7-7	IMAP
" "	H2	IMAP
" "	H3	IMAP
" "	2-1	IMAP
" "	2-1B	spont. morphological variant from 2-1
" "	12-2	IMAP
" "	18-16	IMAP
" "	21-3	IMAP
" "	9-9	IMAP
" "	20-1	IMAP
" "	16-2	IMAP
" "	18-13	IMAP
" "	20-4	IMAP
" "	20-4 A	spont. morphological variant from 20-4
" "	16-1	IMAP

[°] CBS, Centraalbureau voor Schimmelcultures, Baarn; CCFP, Culture collection of Fungi, Department of Botany, Benàtskà 2, Prague; IMAP, Istituto Microbiologia Agraria, Università di Pisa, Italy.

RESULTS

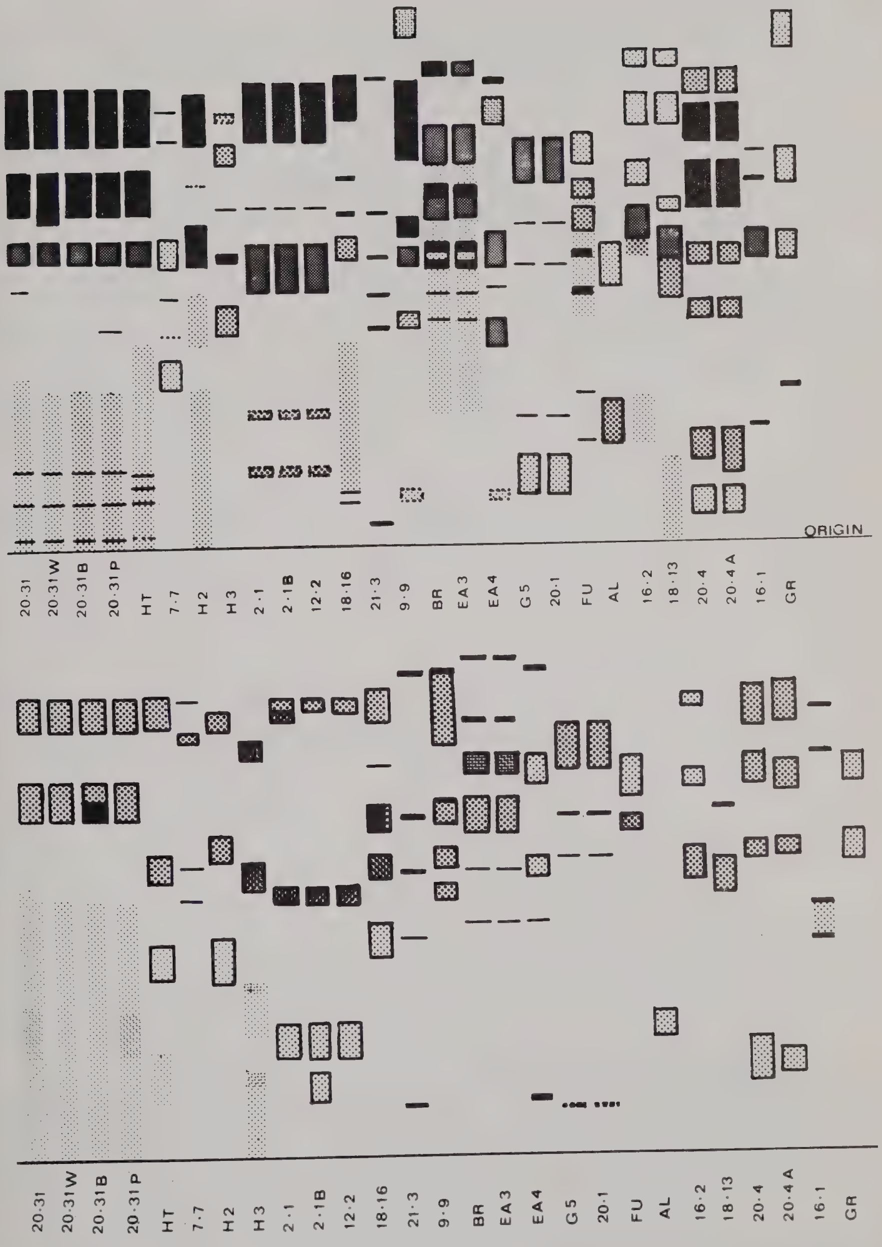
α-Esterases (Fig. 1). All strains produce clear bands of activity for these enzymes. Zymograms show much variation, and among the strains examined eighteen patterns were found. The six type species all give different patterns, and all the new strains are also different from these, with the exception of 20-1 which resembles *H. parvispora*. The two examples of *H. brunnea* are very similar to one another, but are quite different from *H. brunnea* var. *africana*. The morphological segregants all show very similar patterns in their parental strains, examples being 20-31, 20-31B, 20-31P and 20-31W, 20-4 and 20-4A, and 2-1 and 2-1 B. The strains 2-1 and 2-1B also resembles 12-2. Strain HT also resembles 20-31 and its segregants although there are slight differences.

β-Esterase (Fig. 2). The staining for these enzymes is not as good as for α-Est, and with the exception that HT is different from 20-31, those similarities found for α-Est are present for β-Est. Nineteen patterns are found.

Leucine Amino Peptidases (Fig. 3). These enzymes give sharp banding patterns, and although there are few isoenzymes for any strain the similarities found for the esterases are present for L.A.P.. In addition the following strains gave similar patterns: 21-3 and 9-9; 7-7 and HT; *H. fuscoatra* and *H. alopallonella*; 18-16 and 2-1; 16-2 and 18-13; and *H. brunnea* and *H.brunnea* var. *africana*.

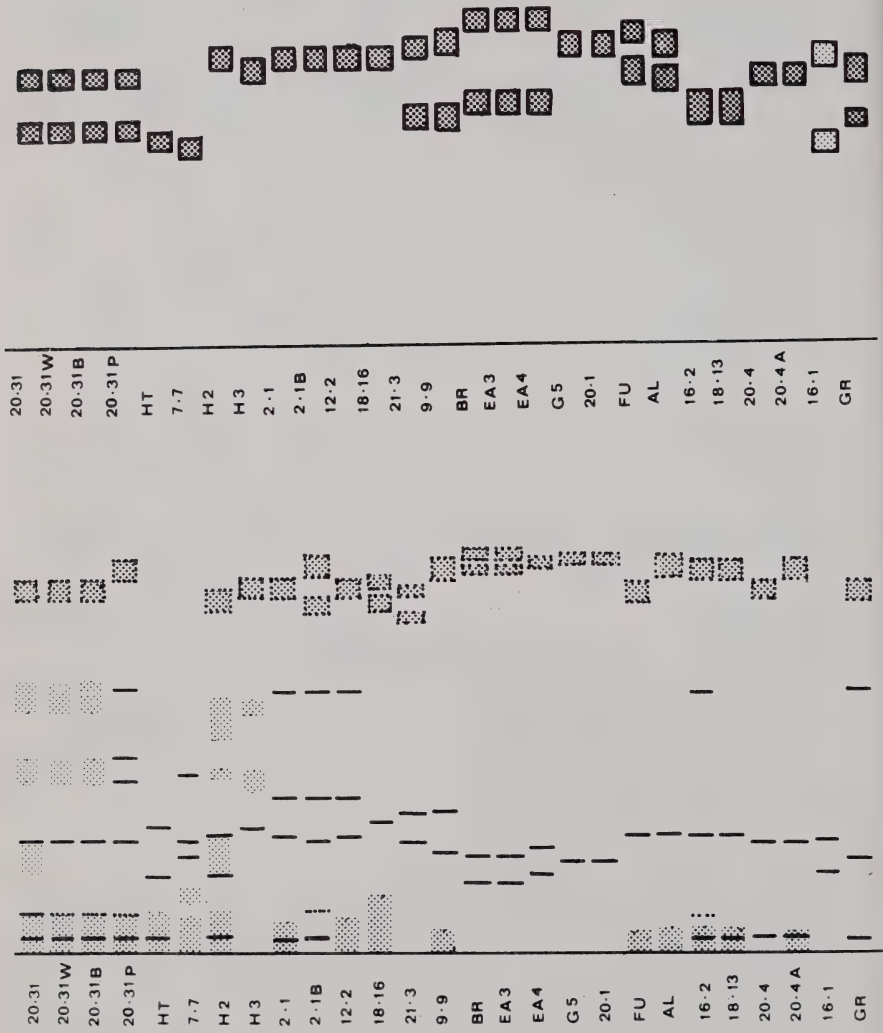
Peroxidases (Fig. 4). These enzymes do not give as clear or consistent bands as the esterases or L.A.P. however, many of the similarities observed previously are again present. *H. parvispora* and 20-1 are again similar as are 2-1 and 12-2; 20-31B and 20-31W; and the two examples of *H. brunnea*. For these enzymes 2-1B shows some differences for its parental isolate as do 20-31P and 20-4A. Some similarities not observed for the esterases are also present. In particular 16-2 and 18-13 are quite similar, and 20-31 with its segregants show several bands in common with 20-4 and its segregant.

Phosphatases-acid (Fig. 5). The level of activity of these enzymes is quite low in many strains especially H2, 16-2 and EA4, although there is in general considerable variation between strains. There are sixteen banding patterns and the groupings are essentially the same as for β-Est, with the additional resemblances of 16-2 to 18-13, 21-3 to 9-9 and *H. alopallonella* to *H. fuscoatra*.

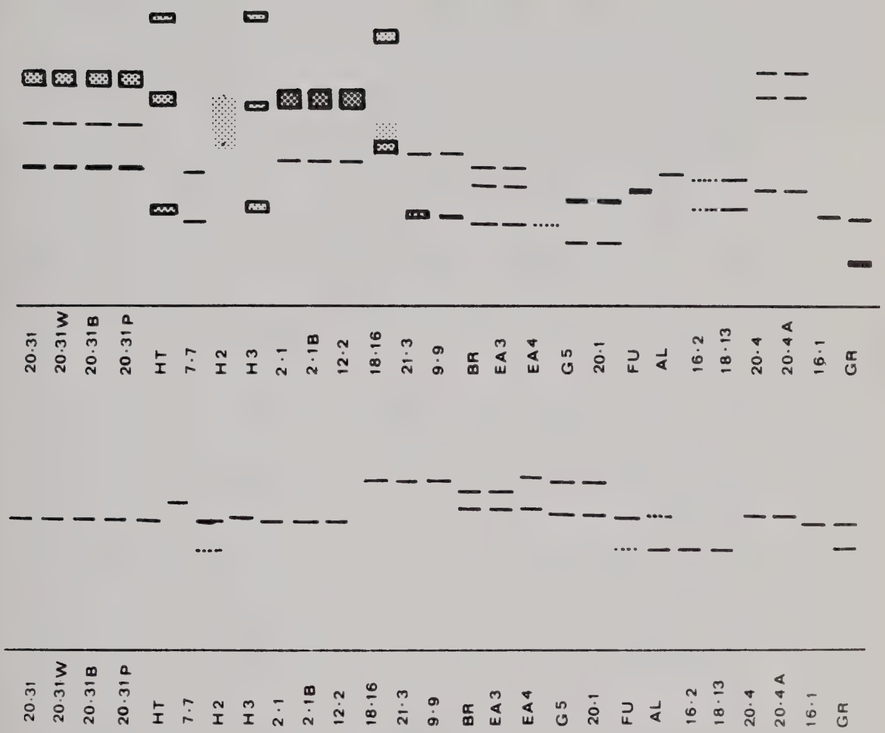

ORIGIN
20·31
20·31W
20·31B
20·31P
HT
7·7
H2
H3
2·1
2·1B
12·2
18·16
21·3
9·9
BR
EA3
EA4
G5
20·1
FU
AL
16·2
18·13
20·4
20·4A
16·1
GR
20·31
20·31W
20·31B
20·31P
HT
7·7
H2
H3
2·1
2·1B
12·2
18·16
21·3
9·9
BR
EA3
EA4
G5
20·1
FU
AL
16·2
18·13
20·4
20·4A
16·1
GR

Figs. 1 and 2. Zymograms of the 27 strains of *Humicola* for the enzymes α-Esterases (Fig. 1) and β-Esterases (Fig. 2).

Phosphatases-alkaline (Fig. 6). Although activities for Pal are generally higher than for Pac, and the banding is also clearer, there is little variation between strains. Those


20·31
20·31W
20·31B
20·31P
HT
7·7
H2
H3
2·1
2·1B
12·2
18·16
21·3
9·9
BR
EA3
EA4
G5
20·1
FU
AL
16·2
18·13
20·4
20·4A
16·1
GR
20·31
20·31W
20·31B
20·31P
HT
7·7
H2
H3
2·1
2·1B
12·2
18·16
21·3
9·9
BR
EA3
EA4
G5
20·1
FU
AL
16·2
18·13
20·4
20·4A
16·1
GR

Figs. 3 and 4. Zymograms of the 27 strains of *Humicola* for the enzymes Leucine amino peptidase (Fig. 3) and Peroxidases (Fig. 4).


20·31
20·31W
20·31B
20·31P
HT
7·7
H2
H3
2·1
2·1B
12·2
18·16
21·3
9·9
BR
EA3
EA4
G5
20·1
FU
AL
16·2
18·13
20·4
20·4A
16·1
GR
20·31
20·31W
20·31B
20·31P
HT
7·7
H2
H3
2·1
2·1B
12·2
18·16
21·3
9·9
BR
EA3
EA4
G5
20·1
FU
AL
16·2
18·13
20·4
20·4A
16·1
GR

Figs. 5 and 6. Zymograms of the 27 strains of *Humicola* for the enzymes Acid Phosphatases (Fig. 5) and Alkaline Phosphatases (Fig. 6).

strains which were found to be similar for the previous enzymes are alike for these enzymes too.

DISCUSSION

The six type species examined showed different zymograms for all enzymes, and the only new strain to resemble any of these was 20-1. This strain was similar to *H. parvispora* for all enzymes, and so may be considered an independent isolate of this species. This agrees with the morphological and biochemical evidences previously published (de Bertoldi *et al.* 1972, Lepidi *et al.* 1972).

When the enzyme characteristics are considered together with the GC% values from Lepidi *et al.* (1972) (Fig. 7) five groups of strains can be recognised. Two of these groups

STRAINS	ENZYMES						G C%
	α-est	β-est	lap	apx	pac	pal	
20·31	△	△	△	△	△	△	33.0
20·31 W	△	△	△	△	△	△	–
20·31 B	△	△	△	△	△	△	–
20·31 P	△	△	△	(△)	△	△	–
H T	△		□	◬	◬	△	30.0
7·7			□				45.7
H·2						△	31.6
H·3				◬	◬	△	28.5
2·1	◆	◆	◆	◆	◆	△	30.2
2·1 B	◆	◆	◆	◆	◆	△	–
12·2	◆	◆	◆	◆	◆		33.2
18·16			◆				29.4
21·3			○		○	○	50.1
9·9			○		○	○	47.5
B R	■	■	■	■	■	■	45.0
EA·3	■	■	■	■	■	■	46.3
EA·4			■				38.5
G·5	◇	◇	◇	◇	◇	◇	41.4
20·1	◇	◇	◇	◇	◇	◇	42.0
F U			●	●	●	●	32.5
A L			●	(●)	●	●	45.0
16·2			□	□	□	□	46.9
18·13			□	□	□	□	43.8
20·4	▲	▲	▲	▲	▲	▲	32.3
20·4 A	▲	▲	▲	▲	▲	▲	–
16·1							30.0
G R							36.3

Fig. 7. Summary of electrophoretic similarity among the 27 strains of *Humicola*. For any enzyme similar simbols represent similar banding patterns. Blanks represent unique banding patterns. GC% values from Lepidi *et al*. (1972).

consist of a wild-type and its segregants and so confirm that these segregants, while differing considerably in morphology, are nevertheless very similar genetically both to each other and to the wild isolate from which they were obtained. Another group contains, in addition to an isolate (2-1) and its segregant (2-1B), the strains 12-2 although these isolates were not previously considered as being closely related. Although the DNA base composition of these strains is not identical, they are similar enough for the difference to be ascribed to experimental error. Another group contains the isolate 20-1 and the type species *H. parvispora,* and the final group comprises the strains of *H. brunnea.* It is not surprising that the strains of *H. brunnea* are alike for all enzymes, but the lack of resemblance of the strain of *H. brunnea* var. *africana* is interesting. From this work it would seem that these taxa are not very similar genetically.

In addition to these five groups, three pairs of strains show partial similarity, although the significance of this is less clear. Two of these pairs (21-3 and 9-9, 16-2 and 18-13) contain strains which were previously seen to bear some resemblances to one another (GC% and aleuriospore size, Lepidi *et al.* 1972) although the other pair contains the two type species *H. fuscoatra* and *H. alopallonella*, which were considered very different. The GC%'s of these species are different and there is therefore no question of them being the same species, although the partial similarity may indicate a common ancestry of these two species.

In general this study has shown the 27 strains of *Humicola* to be very heterogeneous for the six enzymes examined. For most of these enzymes more than sixteen different banding patterns have been found, so there would appear to be much genetical variation present.

These results indicate the problems associated with the taxonomy of the fungi imperfecti, and taxa previously considered very similar have been shown to be quite different, while resemblances have been indicated between others thought to be very different. This method would seem to be useful for this genus, but only if a suffcent number of enzymes are examined.

REFERENCES

Ashton, G.C. and Braden, A.W.H. (1961): Serum β Globulin polymorphism in mice. *Australian Journal of Biological Sciences 14, 248-254.*

de Bertoldi, M., Lepidi, A.A. and Nuti, M.P. (1972): Classification of the genus *Humicola* Traaen: I. Preliminary Reports and Investigations. *Mycopathologia et Mycologia applicata, 46, 289-304.*

de Bertoldi, M., Lepidi, A.A. and Nuti M.P. (1973): The significance of DNA base composition in classification of *Humicola* and related genera. *Transactions of the British Mycological Society, 60, 77-85.*

Brewbaker, J.L., Upadhya, M.D., Makinen, Y. and Macdonald, T. (1968): Isozyme Polymorphism in Flowering Plants: III. Gel Electrophoretic methods and Applications. *Physiological Plantarium 21, 930-940.*

Lepidi, A.A., Nuti, M.P., de Bertoldi,M. and Santulli,M.(1972). The classification of the genus *Humicola* Traaen: II. The DNA base composition of some strains within the genus. *Mycopathologia et Mycologia Applicata, 42, 153-159.*

Nealson, K.H. and Garber, E.D. (1967): An Electrophoretic survey of Esterases, Phosphatases, and Leucine Amino Peptidases in Mycelial Extracts of species of *Aspergillus. Mycologia, 59, 330-336.*

Pontecorvo, G., Roper, J.A., Hemmons, L.M., Macdonald, K.D., and Bufton, A.W.J. (1953): The genetics of *Aspergillus nidulans. Advances in genetics, 5, 142-238.*

Reddy, M.M., and Threlkeld, S.F.H. (1971): Genetic studies of isozymes in *Neurospora*. I. A study of eight species. *Canadian Journal of Genetics and Cytology 13, 298-305.*

Shaw, C.R. and Prasad, R. (1970): Starch Gel Electrophoresis; a compilation of recipes. *Biochemical Genetics, 4, 297-320.*

Wong, A.L. and Willetts, H.J. (1973): Electrophoretic studies of soluble proteins and enzymes of *Sclerotinia* species. *Transactions of the British Mycological Society, 61, 167-178.*

MYCOTAXON

Vol. III, No. 1, pp. 119-125 October-December 1975

REVISION OF CERCOSPORA SPECIES (HYPHOMYCETES) PARASITIC ON PSORALEA

O. CONSTANTINESCU

Mycological Herbarium, Institute of Biological Sciences
Bucureşti 17, Romania

Four taxa of *Cercospora* were described as parasitic on plants of the genus *Psoralea: C. latens* forma *europea* Fragoso (1921), *C. psoraleae-bituminosae* Săvul. & Sandu-Ville (1940), *C. psoraleae* Ray (1941), and *C. psoraleae* Petrak (1950). Chupp (1954) noted only the last three species, considering them conspecific, and regarding *C. psoraleae* Ray as being the correct name. Constantinescu (1967) proposed a new combination, *C. europea* (Frag.) O. Const., for all four taxa, but this is a superfluous name. Almost all authors follow Chupp (1954) in using Ray's name for species of *Cercospora* occurring on *Psoralea* plants.

Examination of the types of the above mentioned taxa, and of other specimens of *Psoralea* parasitized by *Cercospora*-like fungi, showed that *C. psoraleae-bituminosae* is conspecific with *C. psoraleae* Ray and *C. latens* forma *europea* Fragoso, while *C. psoraleae* Petrak is a distinct species. *C. ecuadoriana* is proposed as a new name to replace *C. psoraleae* Petrak. On plants of *Psoralea bituminosa* and *P. drupacea* collected in Spain, Romania, U.S.S.R. and Israel, a new *Cercospora* was found, described here under the name *C. nodosa*.

CERCOSPORA PSORALEAE-BITUMINOSAE Săvul. & Sandu-Ville *in* Mem. Sec. Şt. Acad. Rom., ser. 3, 15(17): 485. 1940.

= *Cercospora psoraleae* Ray *in* Mycologia 33: 176. 1941, non Petrak *in* Sydowia 4: 572. 1950.
= *Cercospora latens* forma *europea* Fragoso *in* Boln R. Soc. Esp. Hist. Nat. 21: 97. 1921.
≡ *Cercospora europea* (Frag.) O. Const. *in* Revue Mycol. 32: 106. 1967.

(FIG. 1)

Leaf spots visible on both leaf surfaces, more or less circular, brown, sometimes becoming pale or whitish in the center, with a darker margin raised on the upper surface, 1-3 mm wide, seldom confluent. Caespituli amphigenous but usually more abundant on the upper surface, composed of 3-20 divergent conidiophores. Stroma substomatal, not well developed, consisting of a few brown cells. Conidiophores macronematous, pale brown, paler towards the apex, straight or geniculated, smooth, uniform width throughout the length or narrowed towards apex, 1-6-septate, simple, 30-100 (-225) µm long, 4-6 µm wide. Conidiogenous cells polyblastic, 1-7 conspicuous conidial scars. Conidia hyaline or faintly greenish, acicular or the young ones short and almost cylindrical, straight or curved, smooth, acute or subobtuse tip, truncate at the base, hilum 2.5-3 µm, 3-17-septate, 40-200 µm long, 3.5-5 µm wide. Few conidia bear at the basal, median, or even apical part, a short appendage on which, occasionally, secondary conidia are formed.

On leaves and stems of *Psoralea bituminosa* L., in Bulgaria, Spain, France, Israel, U.S.S.R., and on leaves of *P. digitata* Nutt., in U.S.A.

SPECIMENS EXAMINED:[1] On *Psoralea bituminosa* L.: BULGARIA, Distr. Caliacra, Balcic, 17 VI 1939, T. Săvul. & Sandu-Ville (41482 lectotype). Isotypes distributed in Săvul., Herb. Mycol. Romanicum 1245. SPAIN, Tibidabo, near Barcelona, 4 V 1919, coll. Caballero, det. Fragoso (41488a, slide *ex* MA; lectotype of *C. latens* forma *europea*); Distr. Logrono, near Arnedo, 7 VII 1930, P. Unamuno (41491 slide *ex* MA); Gran Canaria, near Mogán, 25 III 1954, J. de Urries (41489 slide *ex* MA). The host seems not to be *P. bituminosa* but the fungus agrees with the young state of *C. psoraleae-bituminosae*. FRANCE, Distr. Alpes Maritimes, Grèolières, VIII 1953, G. Durrieu (40418 slide); Distr. Aude, Quillan, 15 VIII 1956, G. Durrieu (40417 slide); Corse, route to Nonza, 27 VI 1949, E. Mayor & Viennot-Bourgin (41487 slide). ISRAEL, Kiriat Akaba, 6 V 1938, coll. (?) T. Rayss, det. O. Const. (41480). Mixed with *C. nodosa*. U.S.S.R., Crimea, Sochi, 27 VII 1912, I. Voronikhin (41477); 4 IX 1913, I. Voronikhin (41478); Gagry, 8 VIII 1912, I. Voronikhin (41479). On *Psoralea digitata* Nutt.: U.S.A., Oklahoma, Stillwater, College nursery, 7 III 1940, W. W. Ray (40419 slide *ex* CUP, holotype of *C. psoraleae* Ray); (40420 slide *ex* CUP 40653, isotype).

A specimen deposited in herb. MA, collected from Valsendera (Gran Canaria), 13 IV 1954, and identified by Urries (1957) as *C. latens* forma *europea*, shows leaves of a Leguminosae plant, parasitized by a "*Cylindrosporium.*"

Cercospora psoraleae-bituminosae is a typical *Cercospora*, morphologically similar to *C. apii* Fres., the type species of the genus.

CERCOSPORA ECUADORIANA O. Const., *nom. nov.*

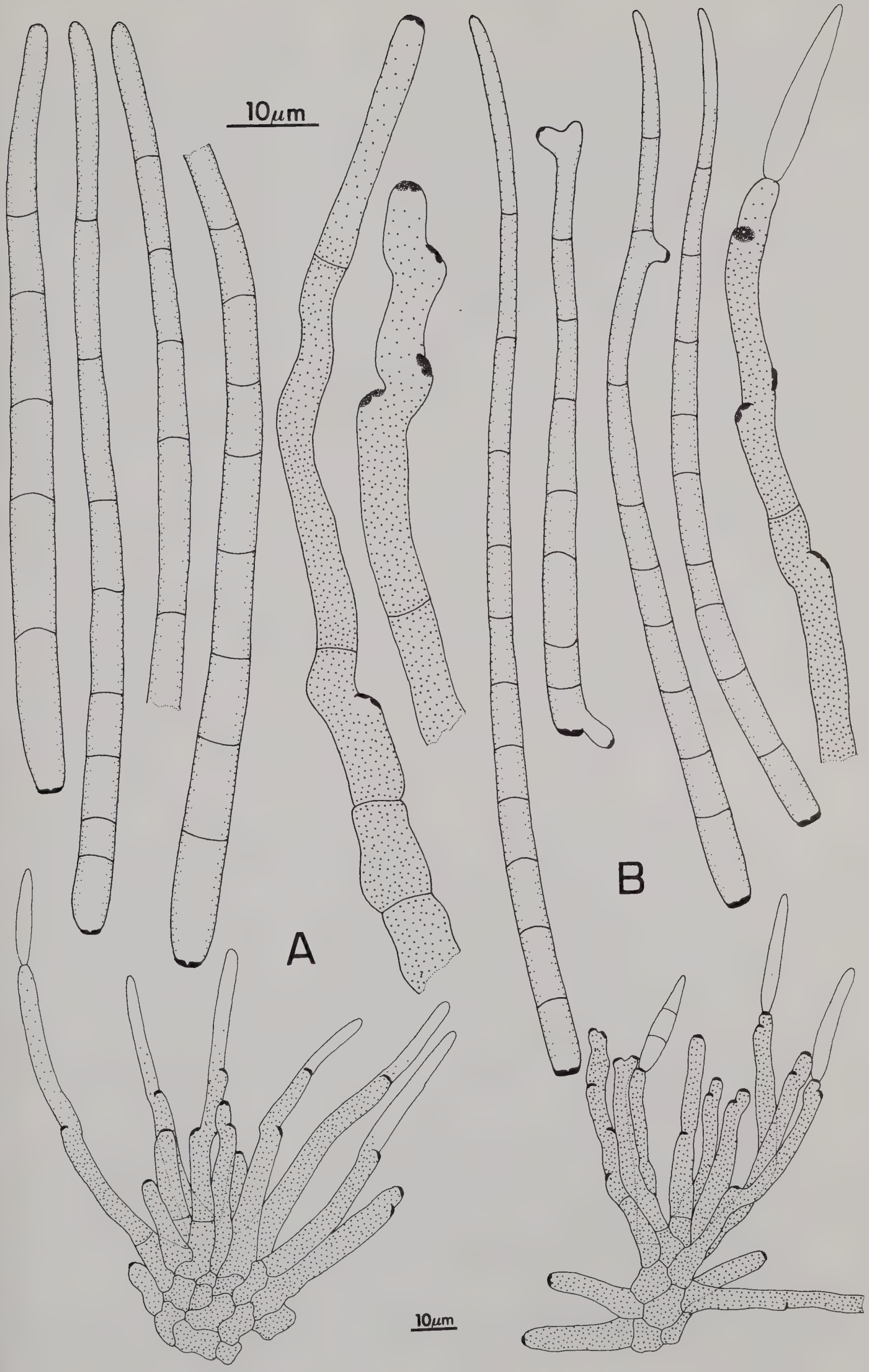
≡ *Cercospora psoraleae* Petrak *in* Sydowia 4: 572. 1950, non Ray *in* Mycologia 33: 176. 1941.

(FIG. 2)

---

[1] Throughout the text, Herb. BUCM identification numbers are given in parentheses after each collection cited.

FIG. 1. *Cercospora psoraleae-bituminosae.* Fascicles, conidia and conidiophore tips. A, from the type (41482); B, from the type of *Cercospora psoraleae* Ray (40419).


10μm
A
B
10μm

Leaf spots visible on both leaf surfaces, irregular, more or less angular. On the upper surface the central part of the spot is pale whitish, 0.5-2.5 mm wide and surrounded by a zone of brown, necrotic leaf tissue, 0.5-1 mm wide. The corresponding area on the lower surface is uniformly brown or paler in the center, 6-7 mm wide. Caespituli hypophyllous, composed of up to 40 conidiophores. Stroma substomatal, up to 40 μm wide, consisting of an aggregation of brown hyphae. Conidiophores macronematous, olivaceous-brown, sometimes paler towards apex, 2-3-septate, width uniform, smooth, straight, curved or geniculated, 30-90 μm long, 4-6 μm wide; conidiogenous cell polyblastic, 1-4 conspicuous thickened conidial scars, 2-2.5 μm wide. Conidia obclavate, faintly greenish, slightly curved, smooth, rounded at the apex, narrowed towards base, hilum thickened, 2.5-3 μm, 3-15-septate, 30-130 μm long, 5-6 μm wide. The mature conidia often bear conidial scars as the result of secondary conidia which are commonly formed.

On leaves of *Psoralea glandulosa* L., in Ecuador.

SPECIMENS EXAMINED: On *Psoralea* sp.: ECUADOR, Pichicha near Quito, 13 IX 1937, coll. P. Sydow, det. F. Petrak, holotype (41481 slide *ex* M).

The obclavate conidia and their more thickened scars differentiate this species from *C. psoraleae-bituminosae*. Although Petrak (1950) reported the host as *P. glandulosa*, the type specimen is labelled *Psoralea* sp. I was unable to identify the host from leaves only.

CERCOSPORA NODOSA O. Const., *nov. sp.*

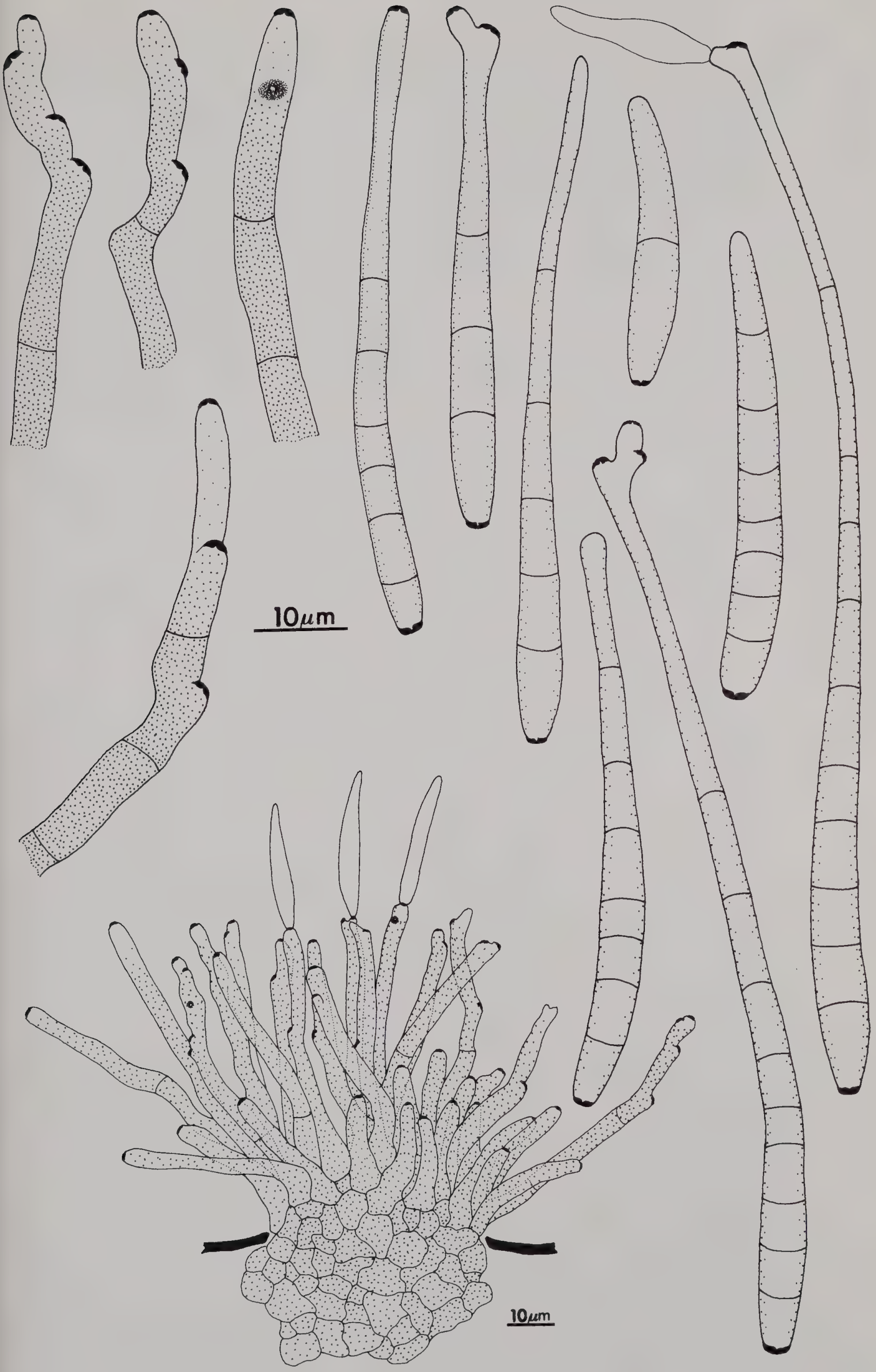
(FIG. 3)

Fasciculi praecipue hypophylli, brunneis, ex stromatibus emergentis, 4-20 conidiophora divergentes compositis. Stroma substromatica, minuta, ex paucis hyphis pallide brunneis composita. Conidiophora pallide brunnea, erecta, plerumque varie crassa, saepe apicem inflata et nodosa, laevia vel apicem verruculosa, 1-2-septata, rare ramosa, 1-4 subtilis cicatrices, 30-50 μm longa, 4-7 μm crassa, apice usque ad 10 μm crassa. Conidia pallide olivacea, obclavata vel brevia et quasicylindrica, plus minusque curvata, laevia, cellis basilaribus interdum delicate rugosus, apices rotundatis, basis truncata, hilum discretum, 2 μm crassum, 1-7-septata, 25-145 μm longa, 4-5 μm crassa.

Habitat in foliis vivis *Psoraleae bituminosae* L., Romania, Bucuresti, Hortus Botanicus, 23 IX 1966, holotypus in Herb. BUCM 41472 conservatur.

Leaf spots visible on both surfaces, brown, 1-3 mm wide, sometimes confluent, vein-limited, necrotic on the upper part and of mosaicated appearance on the lower one. Ceaspituli mostly hypophyllous, brown, emerging through stomatal opening, composed of 4-20 divergent conidiophores. Stroma sub-

FIG. 2. *Cercospora ecuadoriana.* Fascicles, conidia and conidiophore tips from the type of *C. psoraleae* Petrak (41481).


10μm
10μm

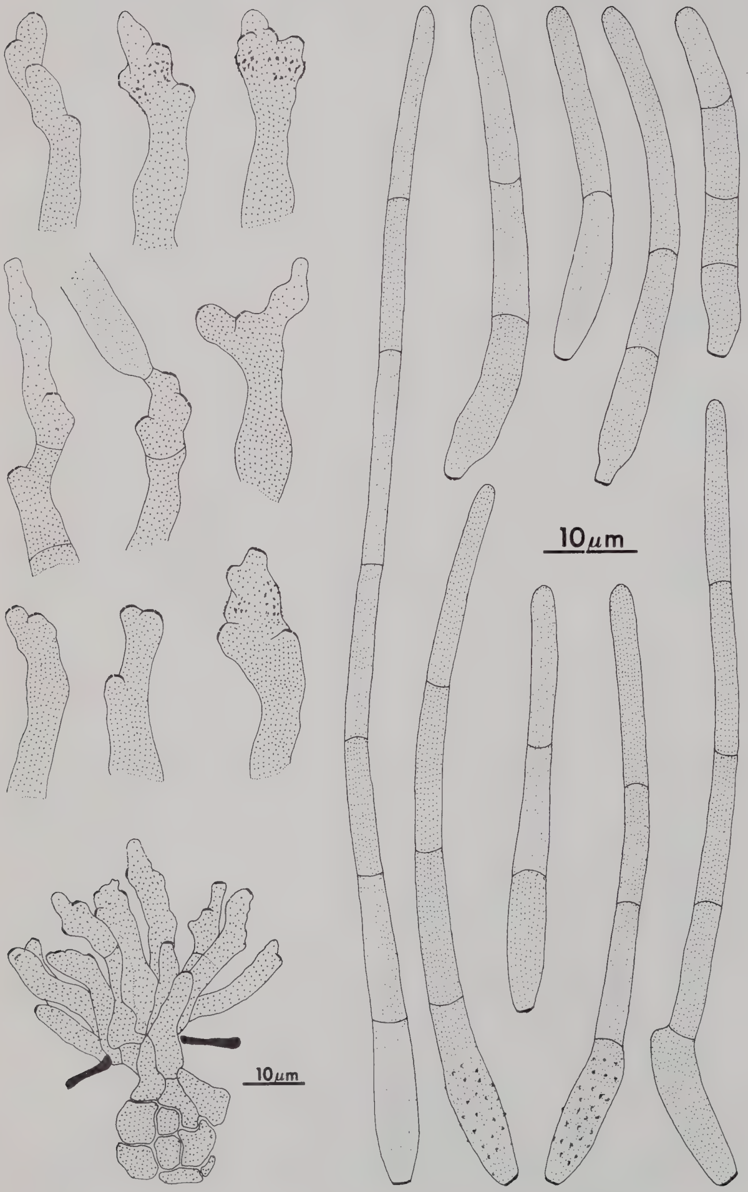


FIG. 3. *Cercospora nodosa*. Fascicles, conidiophore tips and conidia from the type (41472).

stomatal, reduced, consisting of a few pale brown hyphae. Conidiophores brown olivaceous, straight, of different width throughout the length, often swollen and nodose at the apex or just beneath it, smooth walled except some discrete verrucosities on the apical part, 1-2-septate, rarely branched, 30-50 μm long, 4-7 μm wide (up to 10 μm at the swollen tip), conidiogenous cells polyblastic, 1-4 thin, discrete, conidial scars. Conidia pale olivaceous, obclavate but the young ones almost cylindrical, more or less curved, smooth but sometimes the wall of the basal cell verrucose, tip rounded, base truncate, hilum discrete, 2 μm wide, 1-7-septate, 25-140 μm long, 4-5 μm wide.

On leaves of *Psoralea bituminosa* L., in Romania, Spain and Israel, and on *P. drupacea* Bge in U.S.S.R. Type: Romania, Bucureşti, Botanical Garden, 23 IX 1966, O. Const. (41472).

SPECIMENS EXAMINED: On *Psoralea bituminosa* L.: ROMANIA, Bucureşti, Botanical Garden, 23 IX 1966 (41472 holotype; IMI 151119 isotype; CBS 555.71 living culture); 1 X 1966 (41473); 16 VI 1967 (41474) O. Const. SPAIN, Tibidabo, near Barcelona, 4 V 1919, Caballero (41488b, slide *ex* MA). Mixed with *C. psoraleae-bituminosae*. ISRAEL, Kiriat Akaba, 6 V 1938, coll. (?) T. Rayss (41480). Mixed with *C. psoraleae-bituminosae*. On *Psoralea drupacea* Bge: U.S.S.R., Turkestan, Tashkent, 29 VII 1915, N. G. Zaprometov (41475; LE).

C. nodosa belongs to "atypical" *Cercosporae*, having colored conidia and slow growth on culture media (Constantinescu, 1969). By its colored conidia, the discrete, thin, conidial scars, and swollen conidiophore tips it can be differentiated from both *C. psoraleae-bituminosae* and *C. ecuadoriana*.

ACKNOWLEDGMENTS

I wish to thank Prof. G. Viennot-Bourgin – Paris, Dr. Guy Durrieu – Toulouse, and curators of CUP, LE, M, and MA herbaria, for making available specimens in their keeping, and Prof. E. D. Rudolph – Columbus, for correcting the English text.

LITERATURE CITED

Chupp, C. (1954). A monograph of the fungus genus *Cercospora*. Published by the author, Ithaca, N.Y.

Constantinescu, O. (1967). La nomenclature du *Cercospora* parasite sur *Psoralea*. Revue Mycol. 32: 104-107.

-----. (1969). Colony characteristics of some *Cercospora* species. Revue roum. Biol., Ser. bot. 14: 389-394.

Fragoso, G. (1921). Algunos Demaciáceas de la flora espanola. Boln R. Soc. Esp. Hist. Nat. 21: 93-99.

Petrak, F. (1950). Beiträge zur Pilzflora von Ekuador. Sydowia 4: 450-587.

Ray, W. W. (1941). Notes on Oklahoma *Cercosporae*. Mycologia 33: 174-177.

Săvulescu, T. & Sandu-Ville, C. (1940). Quatrième contribution à la connaissance des micromycètes de Roumanie. Mem. Sec. Şt. Acad. Rom., ser. 3, 15(17): 397-502.

Urries, M. J. de (1957). Hongos microscopicos de Canarias. Publ. El Museo Canario 1956-1957(57-58): 1-140.

MYCOTAXON

Vol. III, No. 1, pp. 126-128 October-December 1975

PHIALOCEPHALA GABALONGII AS A SYNONYM OF *PHIALOCEPHALA HUMICOLA*

S. C. JONG and E. E. DAVIS

Mycology Department, American Type Culture Collection,
12301 Parklawn Drive, Rockville, Maryland 20852

SUMMARY

Study of type cultures of *Phialocephala humicola* ATCC 22801 and *P. gabalongii* ATCC 26784 demonstrated that these isolates are identical. Thus, the name *P. gabalongii* Sivasithamparam, 1975, is a later, facultative synonym of *P. humicola* Jong & Davis, 1972.

Sivasithamparam (1975) recently described a new species, *Phialocephala gabalongii* Sivasithamparam, based on an isolate from roots of wheat raised on soil collected from Gabalong, Western Australia. The type culture was deposited in the American Type Culture Collection as ATCC 26784. A comparison of the figures and descriptions of *P. gabalongii* and *P. humicola* Jong & Davis (1972) revealed a similarity in morphological characters as well as in conidiogenesis. Apparently Sivasithamparam was not aware of *P. humicola*. The affinity of *P. gabalongii* and *P. humicola* is therefore discussed in this note.

Phialocephala humicola was fully described and illustrated by Jong & Davis (1972) who originally isolated it from a soil sample collected from Cape May, New Jersey. They reported that conidiogenesis in the fungus appears to be phialidic and conidia are acrogenous. The content of the conidiogenous cell passes through the opening and the conidia take shape immediately on the outside of the opening. This fungus is distinguished from other *Phialocephala* species primarily by the pattern of phialoconidium production and conidium size. According to Tubaki and Ito (1975), *P. humicola* has often been isolated from aquatic sediments of River Ichikawa and Lake Sengari in Hyogo Pref., Japan.

Cultures of *P. gabalongii* ATCC 26784 and *P. humicola* ATCC 22801 were run through a series of tests on a variety of common mycological media under various environmental conditions. The results showed that these strains are morphologically and developmentally indistinguishable (Table 1). *Phialocephala gabalongii* Sivasithamparam (Trans. Brit. Mycol. Soc. *64:* 335, 1975) thereby becomes a later, facultative synonym of *P. humicola* Jong & Davis (Mycologia *64:* 1352, 1972) and ATCC 26784 is now disposed as *P. humicola* at the ATCC.

Table 1. Characteristics of *Phialocephala humicola* and *P. gabalongii* grown on potato dextrose agar (ATCC medium 336) plates for 2 weeks at 24 C

Characteristic	*P. humicola* ATCC 22801	*P. gabalongii* ATCC 26784
Growth at 37 C	No	No
Light required for sporulation	No	No
Colony color	Olive green, reverse dark olive to black	Olive green, reverse dark olive to black
Conidiophores	Macronematous, penicillate	Macronematous, penicillate
Penicillate heads	1-3 metulae	1-3 metulae
Conidiogenous cells	Monophialidic, 8-12 X 1-2 µm	Monophialidic, 5-15 X 1-3 µm
Collarettes	Inconspicuous	Inconspicuous
Phialoconidia	1-celled, differentiated on outside of collarettes 2.5-4.0 X 1.0-2.0 µm	1-celled, differentiated on outside of collarettes 2.0-3.5 X 1.0-2.5 µm

Phialocephala humicola is now known in Australia, Japan and North America, and is well established in different climatic regions of the world. Thus, it has been shown that this species is a clearly defined fungus taxon.

This work was supported in part by National Science Foundation Grant BMS75-06286.

LITERATURE CITED

JONG, S. C., and E. E. DAVIS. 1972. *Phialocephala humicola*, a new hyphomycete. Mycologia 64: 1351-1356.

SIVASITHAMPARAM, K. 1975. Two dematiaceous hyphomycetes with a similar mode of conidiogenesis. Trans. Brit. Mycol. Soc. *64:* 335-338.

TUBAKI, K., and T. ITO. 1975. *Phialocephala humicola* Jong & Davis. *In* Descriptive Catalogue of IFO Fungus Collection IV. IFO Res. Comm. *7:* 119.

MYCOTAXON

Vol. III, No. 1, pp. 129-132 October-December 1975

NOTES ON HYPHOMYCETES. VIII.[1]
LYLEA, A NEW GENUS.

G. MORGAN-JONES

Department of Botany and Microbiology
Auburn University Agricultural Experiment Station
Auburn, Alabama 36830, U.S.A.

ABSTRACT

Lylea catenulata Morgan-Jones, a new genus and species, is described and illustrated from a collection on twigs of *Pinus taeda,* and from agar culture.

INTRODUCTION

During taxonomic studies of dematiaceous hyphomycetes in Alabama an unusual fungus was encountered colonizing bark of dead twigs of *Pinus taeda* L. The organism makes scant growth on the substrate and is therefore not easily observed. It produces scattered, short, branched chains of thick-walled, multiseptate conidia and is, in several characteristics, unlike any other hyphomycete presently known. Since no description of a fungus corresponding to it exists in the literature it is herein treated and a new generic name is established for it. The fungus was easily isolated in pure culture on several agar media.

TAXONOMIC PART

Lylea gen. nov.

Deuteromycotina, Hyphomycetes.

Coloniae effusae, olivaceo-brunneae. Mycelium partim superficiale, partim immersum, ex hyphis ramosis, septatis, pallide brunneis laevibus compositum. Conidiophora micronemata vel semi-macronemata, singulatim ex lateribus hypharum oriunda, simplicia, cylindrica, brevia, pallide brunnea, laevia. Conidia acropetalia, catenulata, catenulis simplicibus vel ramosis, recta vel leniter curvata, cylindrica, brunnea, levia, septata, ad septa non constricta, extremis obtusis.

Species typica *L. catenulata* Morgan-Jones

---

[1] Parts I-VII appeared in the Canadian Journal of Botany.

Lylea catenulata sp. nov. (Fig. 1).

Coloniae effusae, olivaceo-brunneae. Mycelium partim superficiale, partim immersum, ex hyphis ramosis, septatis, pallide brunneis, laevibus vel verrucosis, 1.5 - 2.5µm crassis compositum. Conidiophora micronemata vel semi-macronemata, mononemata, singulatim ex lateribus hypharum oriunda, simplicia, cylindrica, brevia, a mycelio vegetavio vix distincta, pallide brunnea, laevia. Conidia sicca, acropetalia, in catenis simplicibus vel ramosis, acropleurogena, recta vel leviter curvata, cylindrica, brunnea, levia, 1-11 septata, 18 - 120µm longa, 7 - 9µm crassa.
In cortice ramulis *Pini taedae*, Auburn, Alabama, VIII 1973, G. Morgan-Jones, BPI, holotypus.

The new taxon is named in honour of Dr. James Albert Lyle, Chairman, Department of Botany and Microbiology, Auburn University.

Colonies effuse, thin, olive brown, with scattered, branched, conidial chains. Mycelium partly superficial, partly immersed; superficial mycelium composed of slender, flexuous, repent, much branched, septate, pale brown, smooth-walled or minutely verruculose hyphae, 1.5 - 2.5µm wide. Conidiophores micronematous or semi-macronematous, inconspicuous, formed as very short, erect, cylindrical branches of the superficial mycelium, simple, pale brown, smooth-walled, usually separated from the mycelium by a transverse septum. Conidiogenous cells monoblastic, integrated, determinate; constituting the conidiophore, terminal or intercalary on conidia, or intercalary on hyphae. The growth of the conidiophore ceases as the first conidium is formed. A second conidium is formed apically from the terminal cell of the conidium, following which conidia may be produced from the second and subsequent conidia at terminal and intercalary loci. Initial conidia of a chain can form directly from intercalary cells of the repent hyphae, especially in culture, by lateral growth. Conidia catenate, dry, acrogenous, formed in short, frequently branched, acropetal chains, seceding readily, simple, straight or slightly curved, cylindrical, obtuse at each end, thick-walled with narrow cell lumina, guttulate, mid to dark brown, smooth,(1) 4-7 (11) septate (pseudosepta, with thick, dark, conspicuous lamellae), (18) 40 - 67 (120) X 7 - 9µm.

Colonies on 2% malt agar and potato dextrose agar slow-growing, reaching a diameter of 1½ to 2cm. after 21 days, dark olive green, with paler, mottled areas, felted to somewhat floccose in patches especially at the center of the colony, edge regular, becoming darker with age, sporulating abundantly. Reverse dark grey at blackish.

DISCUSSION

Although differing sufficiently to be recognised as a distinct genus *Lylea* bears similarity to a number of known genera. It shows affinity to *Heteroconium* Petrak and *Septonema* Corda in particular. From *Heteroconium*, the genus to which it seems most closely related, it differs in not having well defined, thick-walled, septate, macronematous conidiophores and in possessing

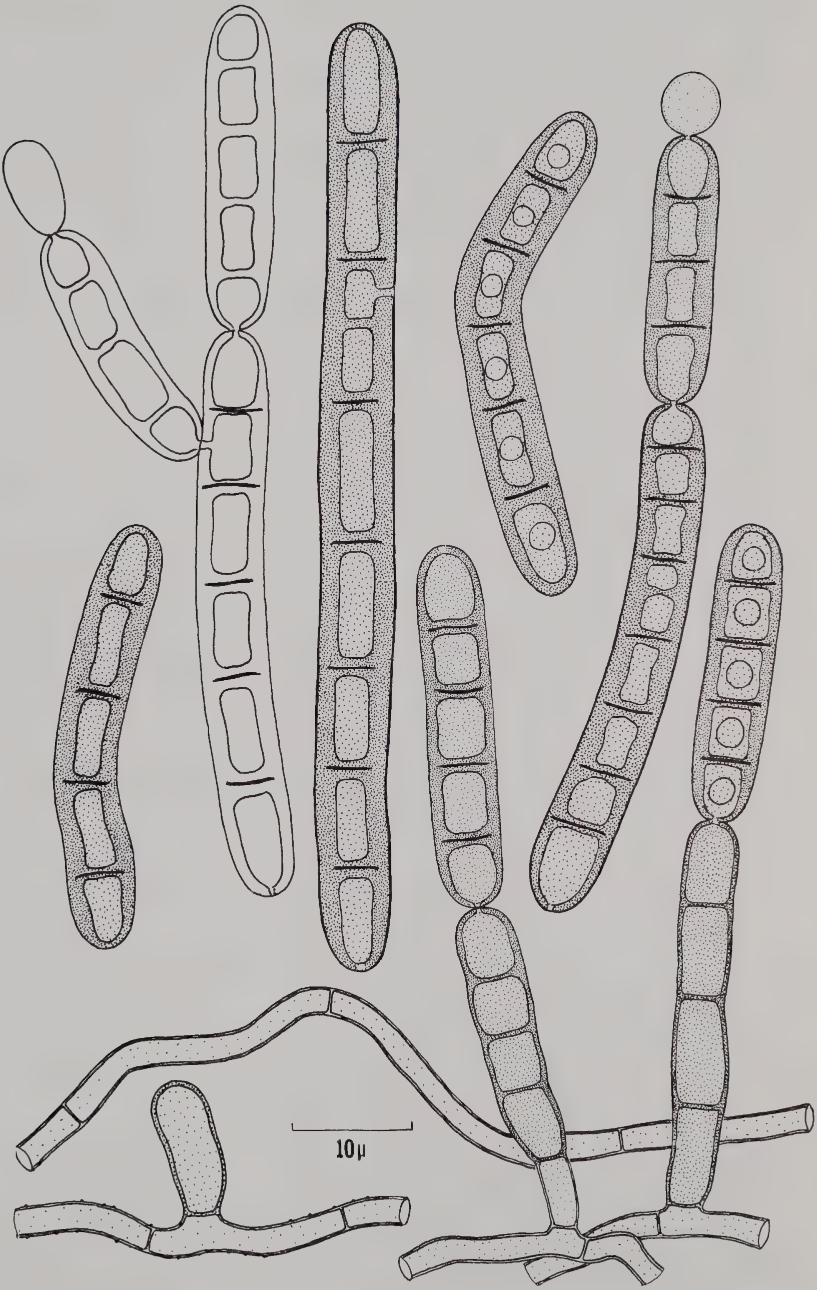


FIGURE 1. *Lylea catenulata*. Conidia and conidiophores.

conidia with thick pseudosepta and reduced cell lumina. Also, the conidial chains of *Heteroconium* are not branched and its superficial mycelium is composed of broad, robust, thick-walled hyphae. A further difference is that *Heteroconium*, as exemplified by *H. citharexyli* Petrak, has largely a superficial habit, hypophyllous on living leaves in the tropics. The name *Heteroconium* is best restricted to foliicolous hyphomycetes which possess short chains of cylindrical, septate, brown conidia that are produced on well developed, erect, septate, thick-walled, brown conidiophores, formed from brown mycelium closely adpressed to leaf surfaces. *Lylea* resembles *Septonema* in that its conidia arise in branched, acropetal chains, but in the latter genus the conidiophores are macronematous, are frequently branched, and are aggregated into a loose sporodochium-like arrangement. The conidia of *Septonema* have simple septa.

Bispora Corda and *Taeniolella* Hughes are similar to *Lylea* in that they possess semi-macronematous conidiophores but the individual conidia in these two genera are delimited from each other by transverse septa and not by complete constrictions as in *Lylea*. In *Taeniolella* the conidia secede only with difficulty. *Ampullifera* Deighton and *Xylohypha* (Fr.) Mason are other genera to which *Lylea* bears some resemblance. They differ from it in their short, ellipsoidal conidia separated by septa and formed on macronematous conidiophores. In the former the presence of hyphopodia on the mycelium in an additional distinction.

Within this complex of genera *Lylea* occupies a position somewhat intermediate between *Heteroconium* and *Septonema*.

ACKNOWLEDGEMENT

I thank Dr. M.B. Ellis, Commonwealth Mycological Institute, Kew, England, for examining this fungus and discussing with me the most appropriate taxonomic position for it.

MYCOTAXON

Vol. III, No. 1, pp. 133-161 October-December 1975

TAXONOMY AND NOMENCLATURE NOTES ON UREDINALES

G.F. LAUNDON

Ministry of Agriculture and Fisheries
Plant Health and Diagnostic Station
Levin, New Zealand

As well as notes on the taxonomy and nomenclature of a variety of rust genera and species, one new name is proposed and six new combinations are given.

The items included here are mostly ones which have arisen in the course of other work during the past five years or so, but which, for one reason or another could not be published along with the results of that work. Notably they relate to work on rust genera for the Index Nominum Genericorum (not yet published) and for my contribution to 'The Fungi' (Laundon, 1973c). These notes should help to explain some of the decisions made therein and elsewhere.

PART A. - MISCELLANEOUS ITEMS

Catenulopsora Mundkur, *Ann. Bot., Lond.* N.S. 7:216 (July (1943).

Cummins (1959) gives this genus as a synonym of *Cerotelium*. Thirumalachar (1960) denies Cummins synonymy and says it is a synonym of *Kuehneola*.

Part of the type specimen (HCIO 13035: *C. flacourtiae* on *Flacourtia sepiaria*, Thirumalachar, 28. x. 1940) was examined. It has erumpent open uredinia (not peridiate with central ostiole); the paraphyses are peripheral, brown, thick walled, irregular, basally septate and adherent; the urediniospores are pedicillate, brown, thin walled (pores not seen). The uredinia, though subepidermal, have a cellular basal layer so that the pedicels of the urediniospores are borne above the epidermis. This cellular layer might be the start of telial formation but appears more likely to be an essential part of the uredinial structure. No telia were found.

Such a rust is most unlike the type species of *Kuehneola* which has non-paraphysate uredinia and urediniospores with hyaline walls. Some other species at present included in *Kuehneola* (e.g. *K. malvicola*) may be more similar but their own status is uncertain. On the other hand the uredinia of *Catenulopsora* agree fully with those of *Cerotelium* and related genera such as *Physopella* and *Phakopsora*. Until telia can be examined the taxonomic status of *Catenulopsora* cannot be resolved. A comprehensive study of *Kuehneola* species would also be desirable.

Coleopucciniella Hara ex Hirats., *J. Jap. Bot.* 13:245 (1937)

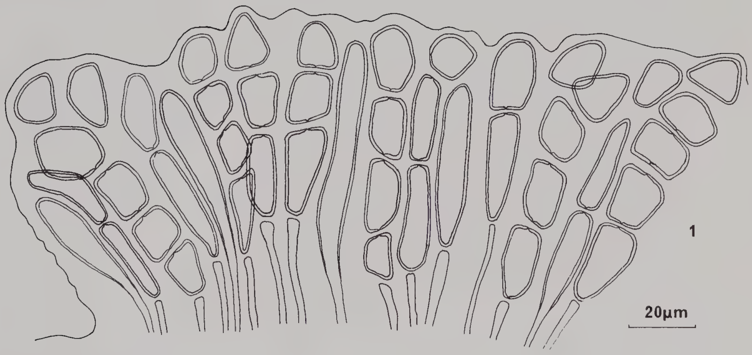
This genus was segregated from *Coleopuccinia* on the assumption that the teliospores of the type species were 1-celled. They had originally been described as 1-celled when the type species *Coleopuccinia simplex* Dietel was first described (*Annls mycol.* 7: 355, 1909), and were again treated as such when the genus *Coleopucciniella* was established. At this time there was still no mention as to how the teliospores were borne.

Later, Thirumalachar & Whitehead (1954) studied both *Coleopuccinia* and *Coleopucciniella* and stated that the two genera were very different. They said that the former had 2-celled teliospores borne on pedicels which early gelatinized and disappeared, whilst the latter had spores which were borne in chains (it appears they meant in basipetal succession).

Cummins (1959) accepted their interpretation of *Coleopuccinia* but apparently did not accept that of *Coleopucciniella* since he united the two genera, describing the teliospores as 1-2-celled and borne on pedicels.

Thirumalachar (1960) repeated the former claims of Thirumalachar & Whitehead (1954) and denied Cummins (1959) treatment of *Coleopucciniella*. To emphasize the point he claimed *Coleopucciniella* was identical with *Chrysomyxa* and made the combination *Chrysomyxa simplex* (Diet.) Thirum.

My own studies of *Coleopucciniella simplex*, and of *C. idei* Hirats. (*J. Jap. Bot.* 13:245, 1937), suggest a different structure from that of either Cummins or of Thirumalachar. My interpretation (Fig 1, 2) is that the telio-



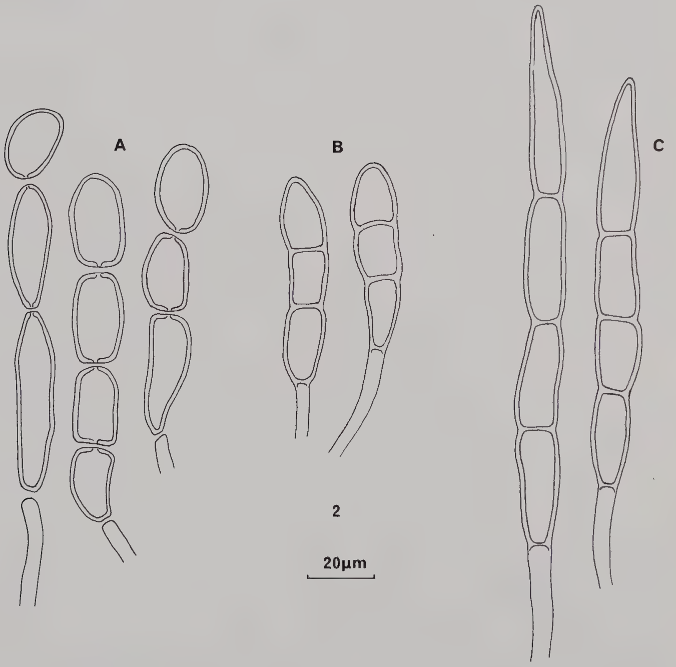


Fig. 1 *Coleopucciniella simplex*, section of part of a telium from specimen ex Herb. Hiratsuka.

Fig. 2 Teliospores of *Coleopucciniella simplex* (A) (ex Herb. Hiratsuka) compared with those of *Gymnosporangium biseptatum* (B) (ex PUR 9842) and *G. ellisii* (C) (ex PUR 10454)

spores are pedicellate phragmospores (as in *Kuehneola*) with 3-5 (or more?) cells. The cells are separate and disarranged in mature telia but sections of young telia clearly show the serial arrangement and I do not think this feature can be doubted. The pedicels are more difficult to see, their being tightly packed at the base of the sorus and agglutinated by gelatinous material. However they were seen in several specimens, most clearly so in PUR F12868; they are elongated (up to 80 µ) cylindric and narrow with very thin or gelatinized walls (narrow teliospore cells can be distinguished by their thick walls).

The general similarity between *Coleopuccinia* and *Coleopucciniella* has long led to the belief that these two genera are closely related. My interpretation is in keeping with this belief and also with Cummins (1959) suggestion that they are derived from *Gymnosporangium*, some species of which possess pedicellate phragmospores also (Fig 2).

But whether or not my interpretation of teliospore structure is correct, it seems very difficult to accept Thirumalachar's idea that *C. simplex* belongs with *Chrysomyxa:* the latter is so different, its species have non-gelatinous telia with teliospores always in a strictly catenulate arrangement and with very thin colourless walls. Moreover, they occur on a very different group of hosts whereas *Coleopucciniella* occurs on Rosaceae, the host predicted by Tranzschel's law if this microcyclic genus is derived from *Gymnosporangium*.

One interesting feature noted in my examination of *C. simplex* was that the species seems to form whole telia successionally: a new telium being formed beneath the old one. The significance of this feature is not apparent to me: it might suggest the whole telium is a unit structure rather like the single teliospore head in *Ravenelia*. I do not know of any other rusts with this feature but if there are any, it could re-open the question of the relationship of *Coleopucciniella*.

Specimens examined: *Coleopuccinia sinensis* (type of *Coleopuccinia*) PUR F1897, F1898; *Coleopucciniella simplex* PUR F12837, F12868, Herb. Hiratsuka, 4. xii. 1941; *C. idei* PUR F12864, F12866; *Gymnosporangium biseptatum* PUR 9837, 9842; *G. ellisii* PUR 10454, 51767.

Coleosporium campanulae (Strauss) Tulasne (not be be attributed to Cooke 1865, cf. Laundon, 1967a), *Ann. Sci. nat. Bot.*

IV 2:137 (1854), cited as "*Coleosporium campanulae* Lév. (*Uredo campanulae* Pers.)" However Léveillé (*Ann. Sci. nat. Bot.* III 8:373, 375, 1847) gives only "*U*(*redo*) *tremellosa* var. *campanulae* Strauss" (p. 373) and "*Uredo campanulae* DC." (p. 375). The former should be considered the basionym of Tulasne's name since it includes the perfect state (like Tulasne's name itself) whilst *U. campanulae* Pers. and *U. campanulae* DC. do not.

Coleosporium rhinanthacearum Tulasne (not to be attributed to Kickx 1867, cf. Laundon, 1967a), *Ann. Sci. nat. Bot.* IV 2:190 & pl.VIII (1854), cited as "*Coleosporium rhinanthacearum* Lév. (*Uredo melampyri* Rebent.)" on "*Melampyrum pratense* L." However Léveillé (*Ann. Sci. nat. Bot.* III 8: 373, 1847) gives only "*Uredo rhinanthacearum* DC." a name applying to the imperfect state whilst Tulasne includes the perfect state, the illustration (pl.VIII, Fig 11) showing teliospores, in accordance with Art. 44 and Art. 59, par. 4 (Stafleu, 1972) making Tulasne's use of the name validly published for a new taxon applying to the perfect state.

It will be noted however that the rust to which Tulasne's name refers is the *Melampyrum* rust, now generally known under the name *Coleosporium melampyri* (Rebent.) Karst. Moreover Tulasne's citation of *Uredo melampyri* Rebent. in synonymy, a name based on the perfect state and the basionym of *C. melampyri*, makes his name superfluous and therefore illegitimate (Art. 63). Accordingly *C. rhinanthacearum* falls into synonymy under *C. melampyri* and another name must be found for the rust on *Rhinanthus*.

Also should be mentioned "*Coleosporium rhinanthacearum* Dec." in Fries, *Summa Veg. Scand.* :512, 1849. This name, which does not include the perfect state, is not validly published (Art. 59, par. 4).

Desmotelium H. Sydow, *Annls. mycol.* 35:252 (-254) (1937).

Desmotelium was originally described as having subcuticular pycnia and teliospores borne in groups on basal cells. Later Thirumalachar & Mundkur (1949) claimed that the pycnia were subepidermal and suggested that the genus might have to be merged with *Chrysocelis* which has subepidermal pycnia.

Cummins (1959) gave *Desmotelium* as a synonym of *Chaconia* and gave the pycnia of *Chaconia* as subcuticular. Later Cummins (1960) made the combination *Chaconia coaetanea* (Syd.) Cumm. for the type species of *Desmotelium*.

Thirumalachar (1960) repeating the former claims of Thirumalachar & Mundkur (1949) made the combination *Chrysocelis coaetaneum* (Syd.) Thirum.

I examined part of the type specimen (IMI 43180) and found the pycnia to be subepidermal, but they are more or less flat and conical, belonging to type 5 of Hiratsuka & Cummins (1963). They are very different from type 4, possessed by *Chrysocelis*. The morphological similarity between type 5 and the subcuticular type 7 of *Chaconia* is more significant than the difference of position between those two types (see the first paragraph of the 'Discussion' in Hiratsuka & Cummins, 1963). *Desmotelium* should therefore be placed with *Chaconia* rather than with *Chrysocelis*.

Further support for this synonymy comes from the life cycle. *Desmotelium* is brachcyclic (with aecial uredinia and true uredinia) just like *Chaconia*, but *Chrysocelis* is demicyclic (with true aecia and no uredinia). Telial structure is a further characteristic for differentiating *Chaconia* and *Chrysocelis*. Unfortunately, from the material of *Desmotelium* available to me I was not able to determine the telial structure, but the original description gives the teliospores as borne in groups of 3-8 on a basal cell as in *Chaconia*.

Elateraecium Thirum., Kern & Patil, *Mycologia* 58:391-396 (28 June 1966).

Elateraecium was described for an unusual distinctive type of aecial state, with two species: *E. salicicola* Thirum., Kern & Patil (type) and *E. divinum* (Syd.) Thirum., Kern & Patil (=*Caeoma divinum* H. Syd., 1931). Almost simultaneously a similar rust was described under the name *Caeoma indicum* Rajendren (*Bull. Torrey Bot. Cl.* 93: 237-240, 23 Aug. 1966) and mention was made of another similar rust *C. callianthum* H. Syd., 1937.

My attempts to obtain specimens of *E. salicicola* from Herb IARI (where the material was said to be deposited), from Thirumalachar, and from Kern have all been unsuccessful. However I have obtained material of *C. divinum, C. callianthum* and *C. indicum*. Studies of these indicate there are probably only two distinctive species of *Elateraecium*. These are *E. salicicola* (=*C. indicum*) which forms systemic infections covering the undersides of the leaves, and sometimes also forming galls and witches' brooms, with prolific growth of elater hyphae which are very conspicuous and give a wooly appearance to the pustules, and with large elongated spores 30-80 x 10-20 µm (mostly 40-50 x 12-15 µm) with coarsely ornamented walls; and *E. divinum* (=*C. callianthum*) which forms local infections on undersides of leaves only, with comparatively few elater hyphae not readily seen except in a slide mount so that the pustules appear powdery rather than wooly, and with comparatively short spores 20-50 x 8-18 µm (mostly 30-40 x 10-15 µm) with less coarsely ornamented walls.

This synonymy must be regarded as tentative. Recently Thirumalachar, Kern & Patil (1973) said they have found the uredinial and telial states of *E. salicicola* and accordingly intend to publish this under the new generic name *Hiratsukamyces* (*Elateraecium* must remain restricted to the aecial state).

Specimens examined: *C. divinum* Herb. S ex USDA 66754 (on *Salacia philippinensis*, Philippines, Clemens, 22 May 1923); *C. callianthum* IMI 43194a (isotype), 46419, 77559; *C. indicum* LEV 5118 ex MACS 265 (isotype on *Salacia* sp., Mysore, India, Rajendren, May 1964).

Gymnoconia Lagerheim, *Tromsø Mus. Aarsh.* 16:142 (1894).

Type species: *G. nitens* (Schw.) Kern & Thurston, *Bull. Penn. State Coll.* 239:16, (1929)
= *Aecidium nitens* Schw., *Schr. naturf. Ges Leipzig* 1:69 (1822) (cited by Lagerheim as "*C. nitens* Schwein.")
= *G. interstitialis* Lagerh. (as"(Schlechtd.) nob.") nom. illeg. (see below).
= *Kunkelia* Arthur, *Bot. Gaz.* 63:501-515 (1917).
Type species: *K. nitens* (Schw.) Arthur.
= *Aecidium nitens* Schw. (see above).

Previous treatments have given the type of *Gymnoconia* as *G. interstitialis* (Schl.) Lagerh. (sometimes referred to by its prior taxonomic synonym, *G. peckiana* (Howe) Trotter). However the basionym *Caeoma interstitialis* Schlecht., 1820, applies to the imperfect state because it is based on aecia from Kamchatka (U.S.S.R.) where only the long cycle form occurs (the short cycle (endo) form not having been recorded outside America except occasionally on imported plants). Therefore contrary to Lagerheim's treatment, this epithet is not eligible for transfer to *Gymnoconia*, a genus applying to the perfect state, and accordingly the author citation for *G. interstitialis* has to be corrected (Art. 59, par. 4).

G. interstitialis Lagerh. applies to the perfect state, being placed in a genus characterized by the perfect state and including in synonymy other names applying to the perfect state, the earliest of which, *A. nitens*, provides the description validating *G. interstitialis* as the name of the perfect state.

A. nitens Schw. applies to the perfect state because it is based on telial aeciospores (which give rise to basidia, Art. 59) from N. Carolina (U.S.A.) far south of the range of the long cycle form. It is therefore eligible to replace *G. interstitialis*, and must do so because it was cited in synonymy by Lagerheim and has priority, both over *G. interstitialis* and over the other synonyms cited by Largerheim. Thus *G. interstitialis* is a superfluous illegitimate name (Art. 63).

The corrected typification of *Gymnoconia* means that it has the same type as *Kunkelia* and therefore that these two genera are obligatory synonyms (typonyms). Previously they have often been segregated, *Gymnoconia* for a long cycle (demicyclic) rust, and *Kunkelia*, for a short cycle (endocyclic) form of the same species. This artificial segregation has been considered not necessary by some authors (e.g. Laundon 1967b) who have treated the two genera as taxonomic synonyms, but those who wish to maintain the segregation will now need to apply *Gymnoconia* to the short cycle form previously known as *Kunkelia*, a new generic name will be required for the long cycle form and it will also be necessary to find or create a species name for the latter.

Gymnosporangium sabinae [Dicks.] Winter, *Hedwigia* 19:55 (1880).

≡ *Tremella sabinae* Dicks., *Pl. Crypt. Brit.* 1:14 (1785).
= *G. fuscum* DC., *Fl. fr.* 2:217 (1805) nom. illeg.

The name *G. fuscum* (recently being used for this species) was nomenclaturally superfluous when published as it included *Puccinia juniperi* Pers., 1801, in synonymy; therefore it is illegitimate (Art. 63). At that time the epithet *juniperi* could have legitimately replaced it; since 1825, however, the combination of this epithet with *Gymnosporangium* would itself be illegitimate owing to the earlier name *G. juniperi* Link, 1825, which applies to a different species. This suggests the possibility that the legitimacy of *G. fuscum* should be restored; however there appears to be no provision for this in the present Code. A possible solution would be to amend the Code to make this provision by adding to the end of Art. 63 the following:

'A name is not illegitimate even if it was nomenclaturally superfluous when published, if the name which should replace it would itself be illegitimate.'

However it is doubtful if this solution could be regarded as satisfactory since it would mean that the legitimacy of the epithet could depend on the genus in which it was being placed. For example, in the case of *G. fuscum*, if the epithet *fuscum* were transferred to another genus where an earlier homonym equivalent to *G. juniperi* Link, 1825 did not exist, then it could not be regarded as legitimate since the epithet *juniperi* Pers. would be eligible to replace it.

As no other satisfactory solution appears possible, this species must be known by the next available name, which appears to be *G. sabinae*.

Hapalophragmiopsis Thirum., *Mycologia* 42:227 (1950)

This genus was established as a segregate of *Hapalophragmium* H. & P. Sydow, 1901, on the basis of its subepidermal pycnia (the type species of *Hapalophragmium* has subcuticular pycnia). Further it was implied that its gall-forming characteristic might be an additional distinctive feature.

Cummins (1959) placed the two genera in synonymy, describing the pycnia as "subcuticular or rarely subepidermal but always with conical form and flat basal hymenium." Subsequently Thirumalachar (1960) insisted that the two genera be separated on the basis of pycnial position.

Hiratsuka & Cummins (1963) listed six species of *Hapalophragmium*, including the type of *Hapalophragmiopsis*, giving two species (*ponderosum* Syd. & Butl., and *millettiae* Syd.) as having subepidermal pycnia, and four (*derridis* Syd., *mysorense* Thirum., *ornatum* Cumm., and *setulosum* Pat.) as having subcuticular pycnia (type 5 and 7 respectively on p. 496; type 9 and 11 respectively on p. 502!). They suggested that the different pycnial types appeared to be associated with different pedicel and teliospore structure: that those with subepidermal pycnia appeared to have pedicels which are septate apically and with an extension up to the upper cell, whilst those with subcuticular pycnia appeared to have pedicels non-septate and with no extension. Thus although the pycnial structure is basically the same in the two genera, a feature considered more important than the difference in position of the pycnia - and therefore suggesting the two genera be united, the suggested correlation with teliospore structure may well justify separation of the two. Hiratsuka & Cummins did not comment on this point but if this were done, it would be necessary to examine the features of *H. pulchrum,* the type of *Triactella* which if found to have the same features as the type of *Hapalophragmiopsis* would have priority over it.

It may be noted that Thirumalachar's suggestion that the gall forming character might be characteristic of *Hapalophragmiopsis* now seems unlikely, since *H. millettiae* which is placed in the *Hapalophragmiopsis* group by Hiratsuka & Cummins (1963) does not form galls.

Kernkampella Rajendren, *Mycologia* 62:837-843 (1970)

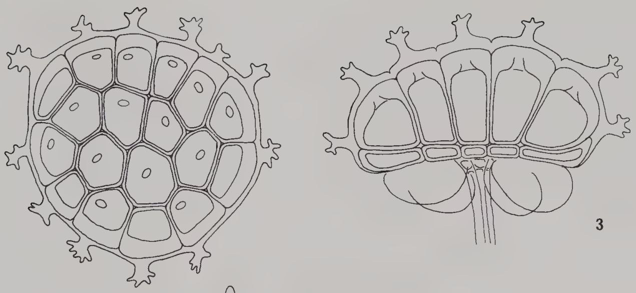
I have investigated the taxonomic status of this genus, segregated from *Ravenelia* Berk., by examination of specimens where suitable ones were available, or failing that, checking the original descriptions. At the outset it should be said that I have not attempted a comprehensive study of *Ravenelia* but I have sought species which might be similar to *Kernkampella* and I have investigated all the species of *Ravenelia* occurring on Euphorbiaceae, the host family of *Kernkampella.*

The results of this investigation are that in my opinion *Kernkampella* is a clearly distinctive genus and that all the species of *Ravenelia* recorded on Euphorbiaceae, except one, should be placed in it. Below I give the necessary new combinations, together with comments and illustrations.

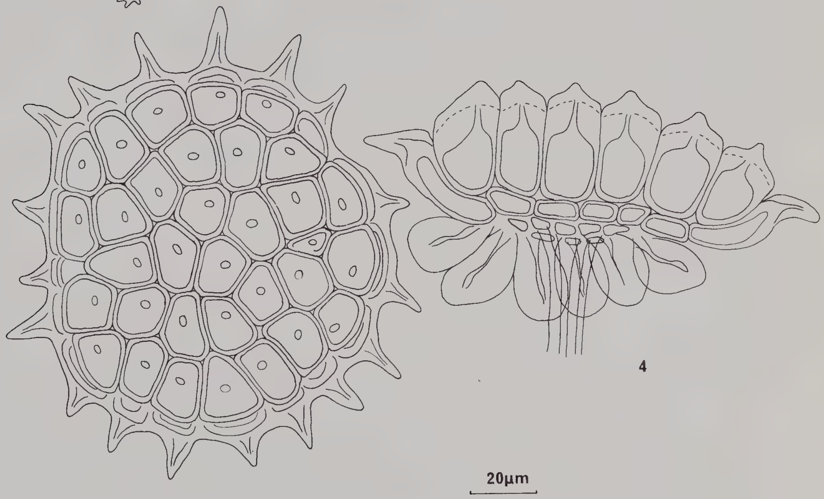
1. *Kernkampella appendiculata* (Lagerh. & Dietel) Laundon, comb. nov. (basionym : *Ravenelia appendiculata* Lagerh. & Dietel, *Hedwigia* 33:65, 1894). Fig 3 is based on Herb. S specimen on *Phyllanthus*, Guatemala, Holway 127, 27 Jan. 1915.

2. *K. brevispora* (Hirats. & Hash.) Laundon, comb. nov. (basionym : *R. brevispora* Hirats. & Hash., *Bot. Mag., Tokyo* 49:522(523), 1935). No specimens seen but the description states that the teliospores are like those of *R. appendiculata.*

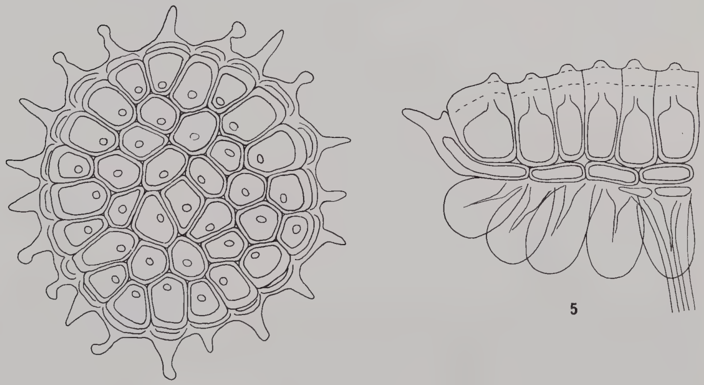
3. *K. breyniae* (Syd.) Rajendren (*Mycologia* 62:839, 1970) Fig. 4 is based on IMI 58945.



3



4



5

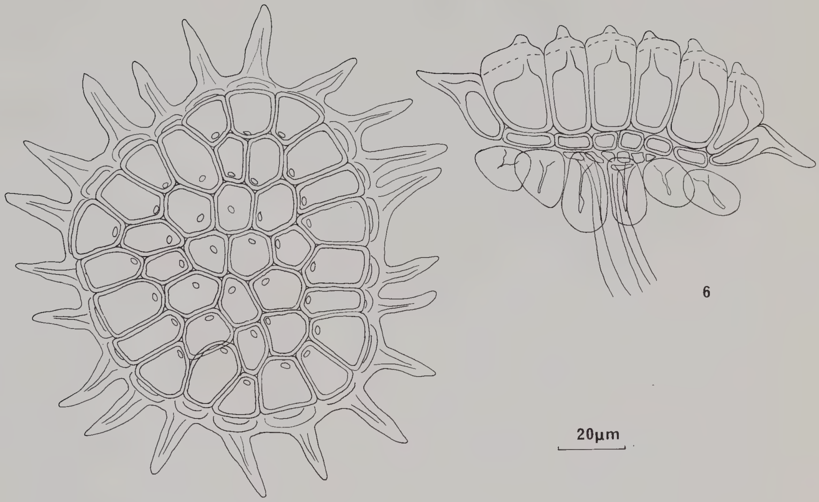
Fig. 3 *Kernkampella appendiculata* teliospore heads.
Fig. 4 *Kernkampella breyniae* teliospore heads.
Fig. 5 *Kernkampella coimbatorica* teliospore heads.

4. *K. breyniae-patentis* (Mundk. & Thirum.) Rajendren (*Mycologia* 62:839, 1970). The type specimen was obtained from Herb. IMI but no teliospores could be found on it, however J. Walker loaned a slide with one teliospore which he had previously obtained from the type specimen from IMI, and another slide showing numerous teliospores from IMI 58496 (ex Sydow, Fungi exotici exs. 223, *R. breyniae* on *Breynia patens*, Ceylon, 1913, ?= misdet. for *R. breyniae-patentis*). The teliospore from the type specimen was rather distorted but clearly agreed with those of the other species of *Kernkampella* which were studied, in so far as a surface view could provide; the same is true of those from IMI 58496 which were in better condition. However, as pointed out by Tyagi (1974) it is clear that the material studied and illustrated by Rajendren under this name does not agree with the type. It appears Rajendren's material may belong to *R. kirganellae* (the only species known to occur in India with branched projections on the teliospores like those shown by Rajendren) although the hosts do not agree. This misidentification does not affect the status of *K. breyniae-patentis*, and although this species is the type of *Kernkampella*, the status of that genus is not affected. At present it is not clear whether the genus must be regarded as based on *K. breyniae-patentis* or on *R. kirganellae* (see Part B) but in any case these two species are congeneric: the original description and illustration of *R. breyniae-patentis* together with the one teliospore seen are clearly of a *Kernkampella*.

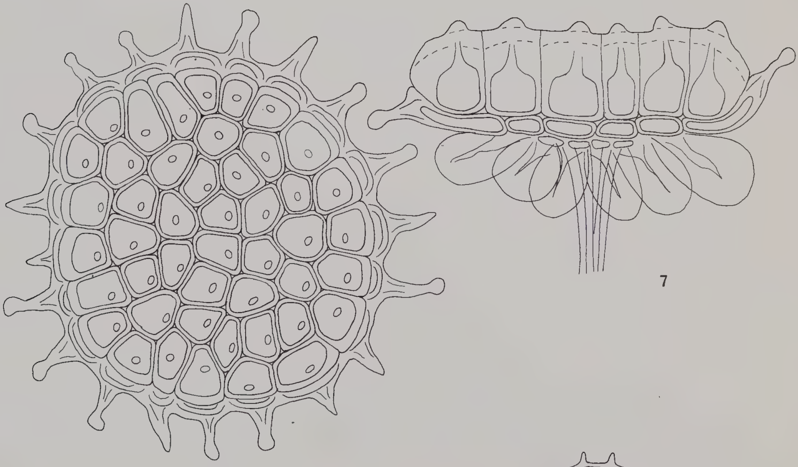
5. *K. coimbatorica* (Ramakr. & Sund.) Laundon, comb. nov. (basionym: *R. coimbatorica* Ramakr. & Sund., *Proc. Indian. Acad. Sci*. B. 35:119, 1952). Fig 5 is based on IARI 19817 (type).

6. *K. emblicae* (Syd.) Laundon, comb. nov. (basionym: *R. emblicae* Syd., *Annls mycol*. 4:438, 1906). Fig 6 is based on IMI 76063.

7. *K. kirganellae* (Mundk. & Thirum.) Laundon, comb. nov. (basionym: *R. kirganellae* Mundk. & Thirum., *Mycol. Pap*. 16:22(-24), 1946). No telial specimens seen (the type and one other specimen were obtained from Herb IARI but no teliospores could be found), however the original description and illustration are clearly of a *Kernkampella*; moreover this may well be the species which Rajendren studied as the type of *Kernkampella* (see under *K. breyniae-patentis*, above.)



6



7

8

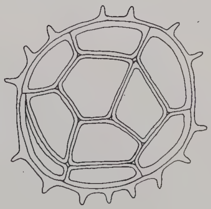


Fig. 6   *Kernkampella emblicae* teliospore heads.
Fig. 7   *Kernkampella phyllanthi* teliospore heads.
Fig. 8   *Ravenelia pygmaea* teliospore heads.

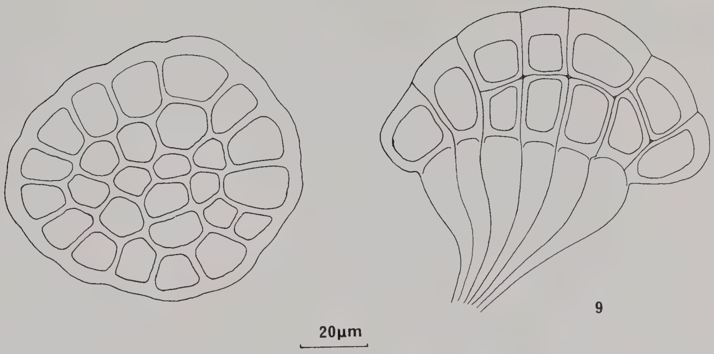
8. *K. phyllanthi* (Mundk. & Thirum,) Laundon, comb. nov. (basionym *R. phyllanthi* Mundk. & Thirum., *Mycol. Pap.* 16: 24, 1946). Fig 7 is based on IARI 10241 (type).

For the purpose of identification the key feature of *Kernkampella* appears to be the presence of the so-called 'epipatella' layer between the teliospores and the hygroscopic cysts. The peripheral epipatella cells are particularly characteristic, elongated in shape and extending a little beyond the margins of the spore head; they have no pores (unlike the teliospore cells) and each one bears a single pointed or branched process at the outer edge, thus providing the teliospore head with a ring of ornamentation. Two features appear to provide rapid recognition of *Kernkampella*, one is the ring of ornamentation with only one projection to each marginal (epipatella) cell, as already mentioned, the other is the presence of a single conspicuous pore for each of the teliospore cells.

Ravenelia sensu stricto has teliospore heads with no epipatella layer and the hygroscopic cysts are joined directly to the teliospores. The central teliospores may be 2-celled but the lower cells are clearly teliospore cells and could not be confused with the epipatella. In those species which have ornamented teliospore heads there are several projections to each marginal cell. I do not know of any true *Ravenelia* species whose teliospores have visible pores. For comparison two *Ravenelia* species are illustrated: the type, *R. epiphylla* (Schw.) Diet. (=*R. glandulosa* Berk. & Curt.) based on IMI 92496 (Fig. 9), and an 'ornamented' species, *R. ornata* Syd. based on IMI 76065 (Fig 10).

I have satisfied myself that *Kernkampella* is quite distinct from *Nothoravenelia* Dietel by examination of *N. commiphorae* (IMI 42558) and do not intend to comment further on this.

There remains one species of *Ravenelia* recorded on Euphorbiaceae which apparently is not a *Kernkampella*. This is *R. pygmaea* Lagerh. & Dietel. However very few teliospores were seen and the structure could not be satisfactorily determined. The teliospores (Fig. 8) differed from *Kernkampella* in having numerous projections for each marginal cell and no visible pores for the teliospore cells. As this species is apparently known only from the type collection and it is the only one recorded on Euphorbiaceae which is not a *Kernkampella*, one wonders if the host has been misidentified. In this connection it is interesting



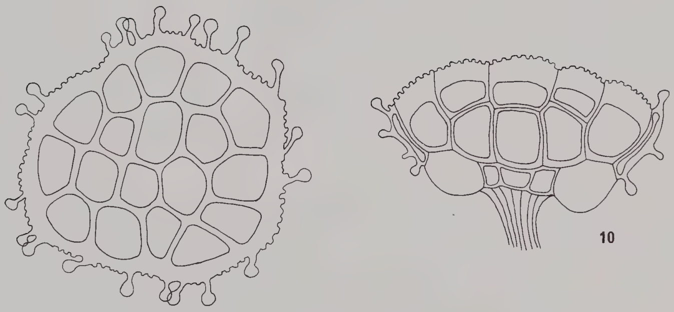


Fig. 9 *Ravenelia epiphylla* teliospore heads.
Fig. 10 *Ravenelia ornata* teliospore heads.

to note that one of the type packets in Herb. S bears the name *Cassia* deleted, suggesting uncertainty about the identity of the host.

Tranzschelia discolor (Fuckel) Tranz. & Litv., *Bot. Zh. SSSR* 24:248 (247-253) (1939).

≡ *Puccinia discolor* Fuckel, *Fungi rhenani exs*. 2121 (1867)
≡ *Puccinia pruni-spinosae* (Pers.) Dietel f. *discolor* (Fuckel) Fischer, *Beitr. krypt. - Fl. Schweiz* 2(2): 157-159 (1904).
≡ *Tranzschelia pruni-spinosae* var. *discolor* (Fuckel) Dunegan, *Phytopath.* 28:424 (411-427) (1938).

P. discolor is validly published since a description is included on the label of the exsiccatum. However both Winter and Dunegan (Dunegan, 1938) have pointed out that the material in packets of Fuckel's exsiccatum of *P. discolor* is of *Tranzschelia pruni-spinosae* (var. *pruni-spinosae*). Dunegan concluded that *P. discolor* could not be the basionym of the subsequent combinations and proposed instead *P. pruni-spinosae* f. *discolor* Fischer as a substitute. I also examined a specimen of Fuckel's exsiccatum from Herb. K. with the same result as Winter and Dunegan. However a different solution to the one Dunegan adopted has been suggested by D.M. Henderson (pers. comm.) and later found to be also suggested by Tranzschel & Litvinov (1939). This solution is as follows:

It is clear that Fuckel described *P. discolor* with the intention of recognizing a species distinct from *P. pruni-spinosae*. As the material in the packets of Fungi rhenani exs. 2121 does not agree with the description on the label of this exsiccatum, then it must be that an error was made in preparing the specimens and the type material of *P. discolor* was mislaid elsewhere. Thus the material in 2121 should not be regarded as the type material.

Tranzschel and Litvinov make the same point (translated from p. 247, last paragraph): "In 1869 Fuckel described and published from his exsiccatum of Fungi Rhenani under the number 2121 (with diagnosis) a new species, *Puccinia discolor*[2], distinguishing it from *Puccinia prunorum* (*Tranzschelia pruni-spinosae*) ..."; (and p. 247 footnote:) "[2] Dunegan (1938) points out that under no 2121 in Fungi Rhenani the samples do not correspond to the description of *Puccinia discolor*. It was the same with the sample of Fuckel's exsiccatum in the Botanical Institute of the Academy of Sciences of the USSR but here there was a handwritten note with leaves of *Prunus spinosa* which reads: "This is to be attached to 330 II, the one of *Puccinia insititia* to no 221"; and in fact under no 330 there were two leaves of *Prunus insititia* with *Puccinia discolor*" (presumably "*Puccinia insititia*" is an error for

Prunus institia and "221" is an error for 2121).

In view of this I checked the specimen of 330 in Herb. K.; however it contained only *T. pruni-spinosae* (var. *pruni-spinosae)*. Despite this it does seem quite reasonable to regard the type material as mislocated so that the status of *P. discolor* as basionym is not affected.

Regarding the status of the other *discolor* combinations: (1) Tranzschel & Litvinov clearly base their combination on *P. discolor* Fuckel: "*Tranzschelia discolor* (Fuckel) n. comb." and they cite the basionym, *P. discolor* Fuckel, and its place of publication. (2) Fischer gives his combination without any author citation and without explicitly indicating the basionym; however *P. discolor* Fuckel is given as a synonym and there is no reason to doubt it was intended as the basionym. (3) Dunegan rejected *P. discolor* Fuckel as basionym and instead gave "*T. pruni-spinosae* forma *discolor* Fischer" (presumably "*T*" is an error for *P*); however since Dunegan's rejection of *P. discolor* was unnecessary and since f. *discolor* was itself based on Fuckel's name, it seems commonsense to regard Dunegan's combination as based on Fuckel's name.

Uromyces fallens (Arthur) Barth., *Handb. N. Amer. Ured.* :61 (1928) (as "(Desm.) Kern").

≡ *Nigredo fallens* Arthur, *N. Amer. Fl.* 7:254 (1912) (as "(Desmaz.) Arthur").
≡ *Uromyces trifolii* var. *fallens* (Arthur) Arthur, *Rusts U.S. Canada* :305 (1934) (as "(Desm.) n. comb.")
= *Uredo fallens* Desm., *Pl. Crypt. Fr.* no. 1325 (1843).
  ≡ *Uromyces fallens* (Desm.) Kern. *Phytopathology* 1:6 (1911) not validly published.

A specimen of Desmazieres *Pl. Crypt. Fr.* 1325, *Uredo fallens* from Herb. K. was examined. Some teliospores are present but were apparently not seen and described by Desmazieres so that the name is to be regarded as uredinial. Concerning the identity of the specimen, both the urediniospores and teliospores agree with the modern concept of this species; the urediniospores with 4-5 pores (average 4.2) of which 73% are in the equatorial position (compare Laundon 1973a); the host agrees with *Trifolium pratense*.

The name *Uromyces fallens* (Desm.) Kern is not validly published because Kern did not describe the telia or teliospores (Art. 59, par. 4). Thus the epithet *fallens* is not preoccupied in *Uromyces* and the later name *U. fallens* (Arthur) Barth. is not affected.

Nigredo fallens is to be considered the basionym for the perfect state since it constitutes the first description of telia. Bartholomew appears to be the first author to include telia under the *Uromyces* combination (he cited *N. fallens* in synonymy), therefore that combination must be attributed to him. Similarly Arthur's variety *fallens* includes telia and *N. fallens*, cited in synonymy by Arthur, must be regarded as the basionym.

Guyot's rejection (1957) of the name *Uromyces fallens* in favour of *U. trifolii* is incorrect. Guyot regarded *Uromyces fallens* as based on *Uredo fallens, wh*ich as shown here it is not; furthermore his assumption that the identity of *Uredo fallens* is no more definite than that of *Uromyces trifolii* is incorrect, as also shown here and pointed out by Kern (1911), i.e. the material of *Uredo fallens* is available for study and readily confirmed to agree with the modern concept of the species. The case against the use of the name *U. trifolii* for this species is given below.

Uromyces nerviphilus (Grognot) Hotson, *Publ. Puget Sound Biol. Stat.* 4:368 (1925).

≡ *Puccinia nerviphila* Grognot, *Pl. Crypt. Saone-et-Loire* :154 (1863).
= *U. flectens* Lagerh., *Sv. Bot. Tidskr.* 3:36 (1909).

The name *U. nerviphilus* has been the subject of some confusion and error. A few early authors (e.g. Sydow, 1910; Grove, 1913) were apparently too uncertain of its identity and used instead the name *U. flectens.* Apparently Arthur (1921) was the first to reintroduce the name, as *Pucciniola nerviphila.* Here the confusion started since Arthur gave the species as a demicyclic one although Grognot had described only telia (Wilson & Henderson, 1966; Jørstad, 1967). Cunningham (1931) and Gaumann (1959) followed Arthur in ascribing aecia to the species but Cunningham stated that he had found only telia and Gaumann gave both a demicyclic species (*U. nerviphilus*) and a microcyclic one (*U. flectens*). Others (e.g. Tranzschel, 1939; Wilson & Henderson, 1966; Jørstad, 1967) have pointed out the error of treating *U. nerviphilus* as demicyclic whilst Guyot (1957) considered the name too uncertain to be used.

The investigations of Jørstad (1967) have indicated that when aecia have been attributed to *U. nerviphilus* this has been because of misidentification of *U. trifolii*-

repentis with suppressed uredinia or of mixed infections of aecia of *U. trifolii-repentis* with microcyclic telia of *U. nerviphilus*. Jørstad concluded that the latter name had to be rejected as a nomen confusum (Art. 69); however I feel this is not necessarily so: it appears to me that both of the examples under Art. 69 are cases where the confusion has been much more serious than for *U. nerviphilus*. Thus this name has been (a) correctly applied to microcyclic telia, (b) correctly applied to telia but with aecia of another species included, (c) incorrectly applied to aecia and telia of another species in an abnormal state, which however is well known by its correct name in its normal state. This is not a case where two distinctive species have been confused, both are correctly known under their respective names, but rather certain abnormal *specimens* have been confused and have led to wrong *descriptions* being given to the species. Moreover it appears the confusion can easily be cleared up since in spite of the apparent non-availability of the type material and the claim of at least one recent author (Guyot 1957) to reject the name as a nomen dubium, there really does seem to be very little doubt about the identity of the species.

It may be worth mentioning that although Jørstad and others use the name *U. flectens* in preference to *U. nerviphilus*, that name (*U. flectens*) was equally confused by Arthur (1921, 1934) and others (e.g. Cunningham 1931) who treated it as a synonym under their demicyclic concept of *U. nerviphilus*. True, by now, *U. flectens* may be less confused than *U. nerviphilus* but perhaps this indicates how easily confusion can be eliminated without the need to resort to Art. 69.

There are two other species in a similar situation to *U. nerviphilus*, these are *U. affinis* Winter and *U. iresines* Lagerh. ex Syd. to which uredinia have been wrongly ascribed. I did not think it necessary to propose new names for these two species (Laundon, 1965b). Probably there are still other species in like situations which other authors have dealt with similarly.

Uromyces trifolii (Hedw. ex DC.) Fuckel, *Symb. Myc.* :63 (1870).

≡ *Puccinia trifolii* Hedw. ex DC. *Fl. fr.* 2:225 (1805).
≡ *Uredo trifolii* (Hedw. ex DC.) DC. in Lamark & Poiret, *Encycl. Meth. Bot.* 8:223 (1808), and in *Fl. fr.* 6:66 (1815).

Three hosts were included under *Puccinia trifolii* Hedw. ex DC. These were *Trifolium repens*, *T. filiforme* and *T. hybridum*. As pointed out by Jørstad (1958) these three hosts are now known to carry various rust species. *T. repens* is host, principally of *Uromyces nerviphilus* and *U. trifolii-repentis* Liro, but also possibly of *U. anthyllidis* Schroet. and *U. striatus* Schroet. (Guyot, 1957). *T. filiforme* (= *T. micranthum*) is host, principally of *U. anthyllidis* and *U. striatus* (Guyot, 1957) but also of *U. minor* Schroet. (Laundon 1973b). *T. hybridum* is host of *U. trifolii-repentis* (although *U. fallens* has also been recorded on this host there is considerable doubt as to the accuracy of these reports, see Laundon 1973a). In an attempt to determine which species were included under *P.trifolii*, J. Walker (pers. comm.) requested De Candolle's material from Herb. G. He received three sheets which might be expected to correspond to the three hosts concerned. However there is nothing to indicate this and it appears that all of them are in fact *T. repens*; certainly none are *T. filiforme* or *T. hybridum*. Only one rust species was present, this being *U. nerviphilus*. Although a further request was made to Herb. G., in the hope that material of the other hosts could be obtained, none was forthcoming.

My conclusions are as follows: (i) the type material is almost certainly heterogenous and one cannot apply Recommendation 7B to the name; thus it is to be rejected under Art. 70. In regard to this conclusion I see no reason to accept the views of Arthur (1912) and Jørstad (1958) that the first listed host, *T. repens*, must be considered to be the type host. (ii) It appears likely that the name has persistantly been used in a different sense (for *U. fallens*, e.g. Sydow, 1909; Grove, 1913; Cunningham, 1931; Wilson & Bisby, 1954; Gaumann, 1959) from that of any of the original material; also it has sometimes been used in other different senses (e.g. for *U. trifolii-repentis*, Kern, 1911; Wilson & Henderson, 1966), thus it has become a long persistant source of error and is to be rejected under Art. 69.

Concerning the author citation for this species and its nomenclatural history, though the combination *U. trifolii* is often ascribed to Léveillé 1847 it was not made by him (cf. Laundon 1967a) but rather was first made by Fuckel (Deighton, pers. comm.). Fuckel gave the basionym as *Uredo trifolii* DC., 1815, but this in turn refers to *Uredo trifolii* in Lamark and Poiret, 1808, and to *P. trifolii*

Hedw., ex DC. 1805. Thus the latter must be regarded as the primary basionym.

PART B. - GENERA DESCRIBED FOR A SPECIES DIFFERENT FROM THAT GIVEN AS THE TYPE SPECIES

Conflicting views have been put forward in regard to the typification of generic names which were described for species different (or possibly different) from those designated as the type, i.e. the species name designated was (or may have been) misapplied (incorrect). On the one hand we have the view that a genus is to be based on the species for which it was described although this species may, at the time, be anonymous (not yet named) (Donk, 1952; Furtado, 1964; Bullock & Hunt, 1966; Bullock, 1966). On the other hand there is the view that a genus is to be based on the type species name designated (Rogers, 1944; Moore, 1966; Weresub, 1967). These views culminated in two proposals (Art. 10, prop, A & C., Stafleu & Voss, 1969) to amend the Code but subsequently no action was taken as it was felt the solution of the problem was not clear and it was decided to postpone a decision until 1975.

In the past I have inclined to the view that a genus is naturally typified by the species which was described ('described' typification). However more recently I have appreciated how seriously this contravenes the type method - one of the most basic tenets of the Code - by throwing into uncertainty the typification of many generic names. Thus I am presently of the opinion that this cannot be permitted and that the 'designated' typification should be upheld. Below I draw attention to a number of rust genera in which this situation occurs and show the consequences of the designated typification. Some of the rust genera given here are of special interest because their situation differs slightly from that in other genera; they involve a genus described for one state being designated with a type based on another state. Thus the typification affects the state to which they apply (perfect or imperfect) rather than (sometimes as well as) their taxonomic status. In addition there are sometimes some other complications.

Argotelium Arthur, *Result. sci. Congr. internat. Bot. Vienne* 1905: 343 (1906).

Designated type "*Uredo hyptidis* Curt." *Amer. J. Sci.* II 6:353 (1848).

SEE ERRATA

Described type: *Argomyces parilis* Arthur, *N. Amer. Flora* 7:217 (1912).
≡ *Puccinia parilis* (Arthur) Arthur, *Amer. J. Bot.* 5:484 (1918).

The typification of *Argotelium*, which included a description of the perfect state (teliospores) is complicated by the type species name being misapplied in two ways. Not only was an imperfect state (uredinial) name misapplied to its type species but also a different species name from the one intended. By designated typification *Argotelium* applies to the uredinial state: *Uredo hyptidis*. This was the approach taken by Arthur (1912a) himself and he therefore proposed the genus *Argomyces* based on *A. parilis* for the concept he originally intended for *Argotelium*. Neither *Argotelium* nor *Argomyces* is in use today, both being treated an synonyms of *Puccinia*.

The nomenclature of the type species is somewhat involved. The name "*Puccinia hyptidis* (Curt.) Tracy & Earle" (*Bull. Miss. Exp. Sta.* 34:86, 1895) must be regarded as a new name based on telia of *P. gibertii* Speg. which was the only telial material included (Art 59, par. 4). Therefore it is to be cited as *P. hyptidis* Tracy & Earle and relegated to the status of an illegitimate synonym of *P. gibertii* (Art. 63) which is now considered to be different species from that of *Uredo hyptidis* (Baxter, 1961). But despite being illegitimate it is validly published and has to be taken into consideration in regard to later homonyms (Art. 64). Thus the perfect state of *Uredo hyptidis* now regarded as a *Puccinia* species has to be given a new name and I propose *P. neohyptidis* Laundon, nom nov., based on *Gymnoconia hyptidis* Lagerheim (*Tromsø Mus. Aarsh.* 17:83, 1895) which constitutes the first description of the perfect state. The name *Agrotelium hyptidis* is presumably in the same position as *P. hyptidis* since the latter name was given in synonymy by Arthur: thus it should be cited *A. hyptidis* (Tracy & Earle) Arthur and is to be relegated to the status of an illegitimate synonym of *P. gibertii*.

Coleosporium Léveillé, *Ann. Sci. nat. Bot.* III 8:373 (1847).

Designated lectotype: "*Uredo rhinanthacearum* DC." in Lamark & Poiret, *Encycl. Meth. Bot.* 8:229 (1808).
New lectotype: *Uredo tremellosa* var. *campanulae* Strauss, *Ann. Wetter. Ges.* 2:90 (1810).
≡ *C. campanulae* (Strauss) Tulasne, *Ann. Sci. nat. Bot.* IV 2:137 (1854).

The genus *Coleosporium* which included a description of the perfect state (telia) had an imperfect state name misapplied to its lectotype species chosen by Arthur (1906) and accepted by subsequent authors (e.g. Laundon, 1965a). In this case the problem can be solved by choosing a new lectotype and I propose *Uredo tremellosa* var. *campanulae* which from its description is clearly telial despite its *Uredo* name.

Frommea Arthur, *Bull. Torrey Bot. Cl.* 44:503 (501-511) (1917).

Designated type: *Uredo obtusa* Strauss, *Ann. Wetter. Ges.* 2:107 (1810) (see note 1, below).
≡ *Puccinia potentillae* Persoon, *Syn. Meth. Fung.* :229 (1801) (see note 2, below).
≡ *Phragmidium potentillae* (Persoon) Greville, *Scot. Crypt. Fl., Syn.* :3 (1828?) (see note 3, below).
≡ *F. obtusa* (Strauss) Arthur (see note 4, below).
Described type: *Phragmidium tormentillae* Fuckel, *Symb. Myc.* :46 (47) (1870) (see note 5, below).

Numerous early authors confused two species which are now regarded as clearly distinctive and which are generally known under the names *Frommea obtusa* and *Phragmidium potentillae*. Unfortunately both of these names, now shown to be based on *Puccinia potentillae*, are obligatory synonyms. Thus by designated typification *Frommea* becomes a taxonomic synonym of *Phragmidium* and a new generic name is required for Arthur's concept of *Frommea* to be based probably on *Phragmidium tormentillae*. Alternatively, by described typification, *Frommea* would be retained distinct from *Phragmidium* with its type replaced by *P. tormentillae*.

Note 1: Like most other authors of his time Strauss confused the two species since he gave their two hosts: *Potentilla argentea* (host only of *Phragmidium potentillae*) and *Tormentilla erecta* (= *Potentilla erecta*) (host only of *Phragmidium tormentillae*). However since Strauss cited *Puccinia potentillae* Persoon in synonymy his name is typified by this (but is not superfluous owing to the prior names *Uredo potentillae* Schum. 1803, and *U. potentillae* DC. 1805, with different types). Why Arthur should have chosen such a name for the type of *Frommea* is a mystery; perhaps he thought that Strauss saw only material of *T. erecta* and that therefore the name could be restricted to that rust only, but, even if this is his reasoning, such a view cannot be upheld.

Note 2: The identity of *Puccinia potentillae* is precise since it includes only one host, *Potentilla argentea*, and the pustules are described as 'nigra', the correct deep black colour for this host (those of *Phragmidium tormentillae* are distinctly paler: chestnut or umber brown).

Note 3: Karsten (*Bidr. Kanned. Finl. Nat. Folk.* 31:49 (1879) is the author usually given as responsible for making the combination *Phragmidium potentillae*, but there were at least two earlier authors of which Greville appears to be the first. Greville's 'Synopsis' which gives this combination, appears to be a summation with revision of his views on the genera in his 'Cryptogamic Flora' (Henderson, pers. comm.). Under *Phragmidium potentillae* he gives the name *Puccinia potentillae* and refers to 'I. Tab. 57' of the Flora (Vol. 1, 1823) where *Puccinia potentillae* is dealt with in more detail. Here the basionym is given: '*Puccinia potentillae* Pers., Syn. Fung. p. 229' together with *Uredo obtusa* Str. There is no doubt that, just like Strauss, Greville confused the two rust species but this does not affect the legitimacy and validity of his *Phragmidium* combination.

Note 4: The combination *F. obtusa* is apparently not illegitimate even though the prior synonymous epithet *potentillae* Pers. should have been used (see the last two paragraphs of Art. 63).

Note 5: Fuckel is apparently the first author to clearly distinguish between the two rust species and he applied the names '*P.(hragmidium) obtusum* Tul.' (see note 6, below) and '*P. tormentillae* Fckl.' to them, with hosts, respectively, *Potentilla argentea* and *P. tormentilla* (= *P. erecta*). Unfortunately he confuses the situation by citing *Ph. potentillae* Cd.' under *P. tormentillae*. Hopefully however, the citation of this name can be regarded either as an error or else intended only to include that part of Corda's 'species' on *T. erecta*. The exsiccatum cited by Fuckel (F. rhen. 2227) is the type material of *P. tormentillae*, and a sample of this obtained on loan from Herb. G. agrees with the species hitherto known as *F. obtusa*.

Note 6: Tulasne (*Ann. Sci. nat. Bot.* IV 2:148, 1854) is not responsible for the combination *Phragmidium obtusum* and the credit for this should apparently (as cited by Tulasne) go to Schmidt & Kunze (*Deutsch. Schwämme* 5:5, 1816 - this publication not cited by Tulasne). Note that Fuckel uses the epithet '*obtusum*' in the contrary sense to that to which the name *Frommea obtusa* has been applied. Since the combination *P. obtusum* is based on *Uredo obtusa* Strauss, it is an obligatory synonym of *P. potentillae* but like *F. obtusa is* not illegitimate (see note 4).

Kernkampella Rajendren, *Mycologia* 62:837-843 (1970)

Designated type: *K. breyniae-patentis* (Mundk. & Thirum.) Rajendren.
≡ R*avenelia breyniae-patentis* Mundk. & Thirum., *Mycol. Pap.* 16:21 (22) (1946)
Described type: ?*R. kirganellae* Mundk. & Thirum., *Mycol. Pap.* 16:22 (-24) (1946).

In regard to the misapplication of the type species name, see above, the taxonomic account of *Kernkampella.*

Physopella Arthur, *Result. sci. Congr. internat. Bot. Vienne 1905*:338 (1906).

Designated type: "*Uredo vitis* Thuem." *Pilze des Weinstockes*: 182 (1878).
Described type: *Phakopsora vitis* Sydow, *Hedwigia* (*Biebl.*) 38:141 (1899).

The genus *Physopella*, which included a description of the perfect state (telia) had an imperfect state (uredinial) name misapplied to its type species. Subsequently Cummins & Ramachar (1958), perhaps unaware of the controversy on this matter, substituted the designated uredinial type with the described telial one, *Phakopsora vitis* Sydow. If it is eventually decided that such substitution will be disallowed then the genus *Angiopsora* Mains will need to be reinstated with *Physopella* applying to its uredinial state. Also depending on the typification of *Physopella* is the status of the name *Physopella vitis.* If substitution of the designated type is not allowed then the name is validly published as a new combination: *P. vitis* (Thümen) Arthur, applying to the uredinial state, but if substitution is allowed so that the genus is telial then *P. vitis* is not validly published neither as a new combination (Art. 59, par. 4), nor as a new name (because it would then be a nomen nudum).

Trichobasis Léveillé in Orbigny, *Dict. Hist. Nat.* 12:785 (1848).

Designated lectotype: *Uredo fabae* Pers. in Roemer, *Neues Mag. Bot.* 1:93 (1974) devalidated name.

Uredo fabae Pers. was chosen as lectotype by Laundon (1967c), who at the time regarded it as uredinial; later it was shown that this species was telial (Laundon, 1968). As *Trichobasis* is an 'imperfect' (uredinial) genus, it therefore conflicts with this lectotype. Although a new lectotype is required I do not feel able to make a choice at present and, as the genus is not now in use there is no urgency on the matter.

I am deeply indebted to the directors and curators of the various herbaria mentioned in the text for the loan of specimens. Also I sincerely thank for their kind assistance, advice and comments: G.B. Cummins, S. Daniels, F.C. Deighton, R.W.G. Dennis, H.B. Gjaerum, D.M. Henderson, N. Hiratsuka, R.B. Rajendren, M.F. Southwell, J. Walker.

REFERENCES

Arthur, J.C. (1906). Résultats Scientifiques du Congrès International de Botanique Vienne 1905, 331-348.

Arthur, J.C. (1912). North American Flora 7, 255.

Arthur, J.C. (1921). North American Flora 7, 448.

Arthur, J.C. (1934). Manual of the rusts in United States and Canada. New York: Hafner (reprint 1962).

Baxter, J.W. (1961). North American species of *Puccinia* on *Hyptis*. Mycologia 53, 17-24.

Bullock, A.A. (1966). Postscript: in defence of *Pseudolarix*. Taxon 15, 264.

Bullock, A.A., & Hunt D.R. (1966). The generic name of the golden larch. Taxon 15, 240-241.

Cummins, G.B. (1959). Illustrated genera of rust fungi. Minneapolis: Burgess.

Cummins, G.B. (1960). Descriptions of tropical rusts. Bulletin of the Torrey Botanical Club 87, 31-45.

Cummins, G.B., & Ramachar, P. (1958). The genus *Physopella* (Uredinales) replaces *Angiopsora*. Mycologia 50, 741-744.

Cunningham, G.H. (1931). The rust fungi of New Zealand. Dunedin: John McIndoe.

Donk, M.A. (1952). On generic type species indicated by misapplied names. Reinwardtia 1, 483-486.

Dunegan, J.C. (1938). The rusts of stone fruits. Phytopathology 28, 411-427.

Furtado, C.X. (1964). Concerning the types of genera. Taxon 13, 237-245.

Gaumann, E. (1959). Die Rostpilze Mitteleuropas. Beitrage zur Kryptogamenflora der Schweiz 12.

Grove, W.B. (1913). British rust fungi. Cambridge University Press.

Guyot, A.L. (1957). Les Urédinées III. genre Uromyces Paris: Paul Lechevalier.

Hiratsuka, Y. & Cummins, G.B. (1963). Morphology of the spermagonia of the rust fungi. Mycologia 55, 487-507.

Jørstad, I. (1958). Nomenclature notes, chiefly on Uredinales. Nytt Magasin for Botanikk 6, 135-140.

Jørstad, I. (1967). *Uromyces* on *Trifolium repens*. Nytt Magasin for Botanikk 14, 19-30.

Kern, F.D. (1911). The rusts of white and red clover Phytopathology 1:3-6.

Laundon, G.F. (1965a). The generic names of Uredinales. Mycological Papers 99.

Laundon, G.F. (1965b). Rust fungi III. Mycological Papers 102.

Laundon, G.F. (1967a). Rust names attributed to Léveillé. Taxon 16, 194-195.

Laundon, G.F. (1967b). Terminology in the rust fungi. Transactions of the British Mycological Society 50, 189-194.

Laundon, G.F. (1967c). The taxonomy of the imperfect rusts. Transactions of the British Mycological Society 50, 349-353.

Laundon, G.F. (1968). The status of some of Persoon's Uredo names. Taxon 17, 179-180.

Laundon, G.F. (1973a). *Uromyces fallens* and *U. trifolii-repentis* in New Zealand. Transactions of the British Mycological Society 61, 83-87.

Laundon, G.F. (1973b). Records and taxonomic notes on plant disease fungi in New Zealand. Transactions of the British Mycological Society 60, 317-337.

Laundon, G.F. (1973c). 'Uredinales in the Fungi IV B edited by Ainsworth, Sparrow & Sussman. New York: Academic Press.

Moore, H.E. (1966). In defence of *Chrysolarix*. Taxon 15, 258-264.

Rogers, D.P. (1944). The genera *Trechispora* and *Galzinia* (Thelephoraceae). Mycologia 36, 70-103.

Stafleu, F.A. (1972). International Code of Botanical Nomenclature. Regnum Vegetabile 82.

Stafleu, F.A. & Voss, E.G. (1969). Synopsis of proposals on botanical nomenclature, Seattle 1969. Regnum Vegetabile 60.

Sydow, P. & Sydow, H. (1909). Monographia Uredinearum 2: 132-134.

Sydow, P. & Sydow, H. (1910). Monographia Uredinearum 2: 360-361.

Thirumalachar, M.J. (1960). Critical notes on some plant rusts III. Mycologia 52: 688-693.

Thirumalachar, M.J. Kern, F.D. & Patil, B.V. (1973). *Hiratsukamyces*, a new genus of Pucciniastrae. International Symposium on Taxonomy of Fungi 1973. University of Madras.

Thirumalachar, M.J. & Mundkur, B.B. (1949). Genera of rusts -1. Indian Phytopathology 2, 65-101.

Thirumalachar, M.J. & Whitehead, M.D. (1954). On the validity of the genera *Coleopuccinia* and *Colepucciniella* (Uredinales). American Journal of Botany 41, 120-122.

Tranzschel, W. (1939). Conspectus Uredinalium URSS. Moscow: Inst. Bot. Acad. Sci.

Tranzschel, W. & Litvinov, M.A. (1939). The rust fungi of the genus *Tranzschelia* on Prunoideae. Journal de Botanique 24, 247-253.

Tyagi, R.N.S. (1974). A critical account of the *Kernkampella*. Indian Journal of Mycology and Plant Pathology 3, 63-66.

Weresub, L.K. (1967). The limited application of the descriptio generico-specifica. Taxon 16, 29-34.

Wilson, M. & Bisby, G.R. (1954). Checklist of British Uredinales. Transactions of the British Mycological Society 37, 61-86.

Wilson, M. & Henderson, D.M. (1966). British rust fungi. Cambridge University Press.

MYCOTAXON

Vol. III, No. 1, pp. 162-164 October-December 1975

ARTHROBOTRYS ENTOMOPAGA IN PURE CULTURE

J. E. ROXON and S. C. JONG

Mycology Department, American Type Culture Collection
12301 Parklawn Drive, Rockville, Maryland 20852

SUMMARY

Arthrobotrys entomopaga, a fungus described by Drechsler as capturing springtails and destroying nematodes, is reported for the first time in pure culture. The strain ATCC 28704 of the fungus produces distinctive predaceous organs that are adhesive knobs rather than the rings and networks in the other species of the genus.

In 1944, Drechsler described a new species, *Arthrobotrys entomopaga* Drechsler (1944), that captured minute springtails and destroyed various nematodes. It is the only species of *Arthrobotrys* that produces predaceous organs which are adhesive knobs rather than the rings and networks which are usual in the genus. Due to its sparse sporulation, Drechsler was unable to obtain it in pure culture. His description and illustrations were based on mixed plate cultures planted with discolored rootlets of *Polygonum pennsylvanicum* L. freshly collected from moist ground near a brook in Arlington, Virginia. As far as we are aware, it has not been reported since then. Citations in literature have been repetitions of Drechsler's original description (Castaner & O'Leary, 1968; Haard, 1968; Rifai & Cooke, 1966).

During a study of *Arthrobotrys* species in culture, we received a culture very similar to *A. entomopaga*. It was originally isolated by J. McCulloch in 1969 from soil in Australia and deposited in the Commonwealth Mycological Institute in England as *Arthrobotrys dactyloides* Drechsler IMI 143,686. The production of aerial sticky knobs on the mycelium suggests that the culture is *A. entomopaga* rather than *A. dactyloides* in which the predaceous organs are of the constricting ring type. Because it represents the second record and the first pure culture of the species and because morphological characters of the fungus can vary considerably between axenic and mixed cultures, the features found in pure culture are described herein.

Colonies on Difco cornmeal agar at 30 C spreading to 7 cm in 7 days, prostrate, hyaline to white. Hyphae smooth, hyaline, septate, often anastomosing, developing numerous upright predaceous organs, consisting of hyaline, globose cells, 6-10 μm in diameter, usually supported by a stalk-like lower cell, varying in length from 4-20 μm. Occasionally a globose cell is developed as the terminal cell of a hypha.

Conidiophores hyaline erect, up to 300 μm, occasionally branched, bearing conidia singly on short sterigmata, grouped in nodes, of which there may be several on a single conidiophore. Nodes may elongate irregularly as additional conidia are produced.

Conidia sympodial-holoblastic, hyaline, cylindrical, rounded at the distal end, tapered at the proximal end, uniseptate, often slightly constricted at the spetum, 11-22 x 5-6 μm (av. 14.5 x 5.9 μm), occasionally developing an adhesive knob at the tapered end.

Chlamydospores intercalary, in chains, hyaline, oval.

According to Drechsler's illustrations and species diagnosis, the adhesive knobs of *A. entomopaga* were ovate to ellipsoid, but in pure culture they are globose. There is no sign of any inner ovoid structure. The conidia of *A. entomopaga* were cited as being 15-28 x 4.5-5.5 μm, longer and more slender than the ones we observed.

In Drechsler's description, the sterigmata of *A. entomopaga* were longer, 2-7 μm and spreading out from the node, leading Rifai and Cooke (1966) to suggest that it belonged in the genus *Candelabrella* Rifai *et* R. C. Cooke, but in the pure culture they are short and irregularly produced, lengthening the node as they increase in number.

Despite these differences, the coupling of typical *Arthrobotrys* conidia with the distinctive predaceous knobs not otherwise known in the genus *Arthrobotrys*, leads to the conclusion that this culture is indeed *Arthrobotrys entomopaga*, and it has been accessioned in the American Type Culture Collection as ATCC 28704.

Since no type material of the species exists, ATCC 28704 is designated as the neotype. A dried plate culture of the isolate is deposited in the Herbarium of the National Fungus Collections, Beltsville, Maryland. At the ATCC the type culture is being frozen and stored in liquid nitrogen at -196 C.

This work was supported in part by National Science Foundation Grant BMS75-06286.

LITERATURE CITED

CASTANER, D., and T. J. O'LEARY. 1968. Nematode-destroying fungi of Missouri II. Variation in conidial dimensions among *Arthrobotrys* species in Missouri. Missouri Acad. Sci. Trans. *4:* 40-45.

DRECHSLER, C. 1944. A species of *Arthrobotrys* that captures springtails. Mycologia *36:* 389-399.

HAARD, K. 1968. Taxonomic studies on the genus *Arthrobotrys* Corda. Mycologia *60:* 1140-1159.

RIFAI, M. S., and R. C. COOKE. 1966. Studies on some didymosporous genera of nematode-trapping hyphomycetes. Trans. Brit. Mycol. Soc. *49:* 147-168.

MYCOTAXON

Vol. III, No. 1, pp. 165-172 October-December 1975

VARIATION IN ASCOMYCETE IODINE REACTIONS: KOH PRETREATMENT EXPLORED

LINDA M. KOHN AND RICHARD P. KORF

Plant Pathology Herbarium, Cornell University, Ithaca, NY 14850

and

Exe Island Biological Station, Portland, Ontario K0G 1V0

SUMMARY

Dried apothecia of species of 3 Inoperculate Discomycete genera, *Pezicula, Dermea,* and *Chloroscypha,* all showed non-reactive ascus apices when rehydrated in water and mounted in Melzer's reagent, but when rehydrated instead in dilute KOH solutions displayed intensely blue apical ascus mechanisms. Other anomalous iodine reactions in Ascomycetes are reviewed here, and some other chemical pretreatments noted. Workers are urged to use KOH pretreatment routinely before concluding that asci are iodine-negative. The dangers of using existing keys that stress iodine reactions are evident, since authors have not indicated whether they rehydrate in KOH or not.

Iodine solutions, usually in combination with potassium iodide (Lugol's solution) or with potassium iodide and chloral hydrate (Melzer's reagent), have been used by lichenologists for well over a century following their popularization by Nylander to effect differential blue staining of hymenial elements. Many mycologists later adopted the use of iodine, in particular the Melzer's formulation.

THE MELZER'S REACTION

Among the significant positive reactions in Melzer's reagent reported in the literature, and some convenient references to these, are:

(1) blueing of the ascus pore in some Inoperculate Discomycetes and in some Pyrenomycetes (Dennis, *1968*);

(2) blueing of the ascus apex in *Peziza* and related genera of the Operculate Discomycetes (Dennis, *1968*), and in some members of the Tuberales (Trappe, *1975*);

(3) diffuse blueing of the ascus surfaces in *Pachyella* (Pfister, *1973*) and in *Iodophanus* and its allies (Kimbrough and Korf, *1967*), members of the Operculate Discomycetes;

(4) intense blueing of various hymenial elements in many lichens (Poelt, *1973*) and in some members of the Ostropales (Dennis, *1968*);

(5) blueing of ascocarp tissues in some species of *Lambertella* (Dumont, *1971*), in some species of *Vibrissea* (Sánchez, *1967*), and of apothecial gels in *Pezoloma iodocyanescens* (Dennis & Korf) Korf (Dennis and Korf, *1958*), all Inoperculate Discomycetes, and blueing of subhymenial tissues in some Ostropales (M. A. Sherwood, *pers. comm.*);

(6) blueing of ascospores in *Strossmayeria* (Korf, *1973*), an Inoperculate Discomycete;

(7) the violet or red reaction of the spore contents in some lichens (M. A. Sherwood, *pers. comm.*, but termed "I+ blue" by Hale, *1974*);

(8) the amber ("dextrinoid") reaction of the ascus contents in *Pachyella* (Pfister, *1973*), an Operculate Discomycete, and in some basidiospores (Singer, *1975*);

(9) the black reaction of basidiospore ornamentation in the Russulaceae (Singer, *1975*).

Of these reactions, we are primarily concerned in this paper with Melzer's reagent induced blueing of the ascus pore and ascus walls in Discomycetes, and in the effects of chemical pretreatment, particularly with potassium hydroxide, on the expression of such Melzer's reactions. The term "amyloid," traditionally used for the blueing reaction (or for the black reaction of Russulaceae epispore ornamentation), is avoided here in favor of the terms "blueing in iodine" and "iodine positive." Because the reaction and its specificity is poorly understood, and because "amyloid" specifically implies the presence of amylose or of a substance chemically related to amylose, the accuracy of the term is dubious. Similarly the terms "dextrinoid" and "pseudoamyloid," used for the amber reaction in iodine solutions, are equally misleading.

Some Melzer's reactions, such as those noted above, are quite stable throughout a taxon. Korf (1962) stated that "Natural genera are remarkably constant in regard to the presence or absence of [the iodine positive blueing reaction] ... which thus appears to offer some fundamental criterion in classification, perhaps linked to ascospore discharge mechanisms."

REPORTS IN THE MYCOLOGICAL LITERATURE OF VARIATION IN THE MELZER'S REACTION WITHIN A SPECIES

Over the years some workers, Seaver (*pers. comm.* to the junior author) for example, have chosen not to use iodine perhaps because they felt the reaction was too variable. While the earliest reported variations in the reaction were by lichenologists, Nannfeldt, as reported by Munk (*1957*) was apparently the first mycologist to do so when he reported that, unlike other members of the Xylariaceae, *Hypoxylon serpens* (Pers. ex Fr.) Kickx failed to have ascus apices turning blue in iodine in some collections. Munk studied ascus apices of three collections of this species: the first was iodine negative, the second turned faint purplish brown, and the third gave a distinct blackish blue reaction. Eriksson (*1966*) reported that he could get all ascus apices in *H. serpens* to blue uniformly in Melzer's reagent if he pretreated first with sodium hydroxide and then with nitric acid. Although this technique was first reported by Minks (*1881*), a lichenologist, it had hitherto been overlooked by mycologists.

Korf (*1962*) drew attention to Sydow's report of *Sarcotrochila balsameae* (Davis) Korf, an Inoperculate Discomycete, as iodine negative, whereas all collections he examined had iodine-positive asci, including material that Sydow had examined. As he pointed out, Sydow may have missed seeing the reaction, may have incorrectly reported it, or Sydow's comment might not even have been in reference to asci.

Müller and Hütter (*1963*) drew attention to a collection of *Chloroscypha sabinae* (Fuckel) Dennis, an Inoperculate Discomycete, which had iodine-positive asci; Dennis (*1956*) had described the species as having iodine-negative asci. Parker and Reid's (*1969*) examination of a portion of this collection in the Herbarium of the Royal Botanic Gardens, Kew, and their comparison of it to the iodine-negative collections cited by Dennis proved the collections identical in every respect except pore reaction. They discovered a second iodine-positive collection in the same herbarium.

Variation in the iodine reaction within a species may sometimes indicate morphological differences of a profound nature, and may lead to taxonomic improvements. While Weir (*1917*) and Brandt (*1960*) both published reports of iodine-positive asci in *Rhabdocline pseudotsugae* Sydow, others reported only iodine-negative asci. An explanation was offered in the monograph of the genus *Rhabdocline* by Parker and Reid (*1969*), who reported that the iodine-negative collections of *R. pseudotsugae* completely lacked both a thickened apex and an apical pore, while iodine-positive collections bore asci with an apical starch-like cylinder perforated by a central pore. On this basis they designated a new species of *Rhabdocline, R. weirii,* to accommodate iodine-positive collections. Parker and Reid tried KOH pretreatment to induce an iodine positive reaction in *R. pseudotsugae,* but failed to do so since the absence of an apical ascus pore in this species was the actual reason for this perplexing variation in blueing.

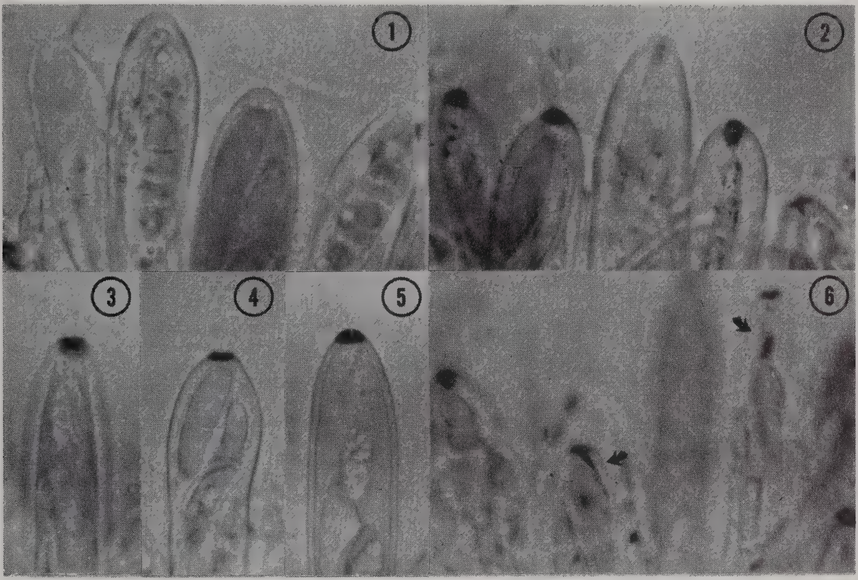
VARIATION IN MELZER'S REACTION INDUCED BY PRETREATMENT WITH POTASSIUM HYDROXIDE

In our laboratory we came upon a clue to one type of variation in the Melzer's reaction through our frequent use of a 2% aqueous solution of KOH as a rehydrating agent for dried material. On two independent occasions, once by the senior author, once by Martha A. Sherwood, we discovered, quite by accident, that dried collections of species referable to the Inoperculate Discomycete genus *Pezicula,* when rehydrated in water did not blue in iodine (FIG. 1), but when rehydrated in KOH, all ascus pores blued dramatically (FIG. 2).

Only very recently have we discovered that Minks (*1881*) had already observed exactly the same phenomenon in three species, *Patellaria rubi* Lib., *P. livida* Berk. & Br., and *Dermatea laricicola* Fuckel, all of which today are considered members of *Pezicula,* the same genus in which we rediscovered the phenomenon, nearly a century later.

Accordingly, we looked at several species of *Pezicula* and at species of several other genera to determine whether pretreatment with KOH might induce blueing in the ascus pore. Apothecia from each collection were rehydrated in distilled water and in 2% and 10% aqueous KOH solutions for at least 15 minutes. Such prolonged exposure to KOH is not required, at least in *Pezicula,* since material blued in Melzer's reagent after instantaneous immersion in either KOH solution. Prior to mounting in Melzer's reagent (our formula: 0.5 gm iodine, 1.5 gm KI, 20 gm chloral hydrate, 20 ml distilled water), apothecia were rinsed in distilled water to remove excess KOH.

We found KOH-induced blueing in all species which we examined of *Pezicula,* of *Dermea,* and of *Chloroscypha,* three large Discomycete genera. In none of the collections of any of these



FIGS. 1-6. Asci of *Pezicula acericola* (Peck) Sacc., rehydrated as noted and then mounted in and photographed in Melzer's reagent, CUP 54700. 1. Asci in several stages of development, rehydrated in water. 2. Asci in several stages of development, rehydrated in 2% KOH. 3. Young ascus rehydrated in 2% KOH. 4. Nearly mature ascus rehydrated in 2% KOH. 5. Fairly mature ascus rehydrated in 10% KOH. 6. Several asci showing disruption of the apical mechanism, with trailing portions of iodine-positive material (arrows), rehydrated in 10% KOH.

three genera was there a positive reaction when rehydrated only in water.

If, indeed, Dennis rehydrated *Chloroscypha sabinae* in water, and Müller and Hütter as well as Parker and Reid rehydrated those collections in KOH, the variation in iodine reactions may be thus explained. More likely, it may be that, as in *Hypoxlon serpens*, real variation in the iodine reaction occurs among collections, even though we have not demonstrated this in material we have examined.

We noted that exposure to 10% KOH tends to produce a much more blue-black reaction (FIG. 5) on iodine-positive asci than does exposure to 2% KOH (FIGS. 2, 3, 4). Also 10% KOH clearly disrupts the apical mechanism in some species (FIG. 6), a feature we did not see in pretreatment with 2% KOH.

ANOMALOUS MELZER'S REACTIONS UNCHANGED BY KOH PRETREATMENT

Cases exist in which an anomalous reaction to Melzer's reagent cannot be changed by pretreatment with KOH. Recently, while evaluating the Tuberalean genus *Caulocarpa*, Trappe (*1975*) acquired fresh specimens of *C. montana* Gilkey from the type locality. He found that while his collection was in other respects identical to the type collection, in fresh material the asci blued strongly in Melzer's reagent while in the type material, long preserved in glycerol-ethanol, the asci were iodine-negative. Fortunately, some dried-out microscopic mounts prepared from the type collection when it was fresh were found among Dr. Gilkey's slides, and this material blued beautifully. We examined a portion of the gylcerol-ethanol preserved type collection in our laboratory and found KOH pretreatment useless in inducing a blue reaction in Melzer's reagent; long immersion in glycerol-ethanol apparently alters the composition of some substance reactive in iodine.

Variation in fresh and dried material has also been reported in the literature. Pfister (*1973*) observed that in some species of *Pachyella* the asci blue diffusely when fresh, but fail to blue when dried and rehydrated. Again in our laboratory KOH pretreatment failed to induce blueing in such dried material. Just the opposite effect was found by Dennis as reported by Parker and Reid (*1969*). In this instance a collection of *Peziza repanda* Pers., normally expected to blue in iodine, failed to do so when fresh, but on drying showed a positive reaction to Melzer's reagent. We have not noted such a phenomenon in our collections of *Peziza*, and offer no explanation for it.

VARIATION IN MELZER'S REACTIONS INDUCED BY CHEMICAL PRETREATMENTS OTHER THAN POTASSIUM HYDROXIDE

Our preliminary studies of chemical pretreatments other than KOH have demonstrated that while 2% aqueous sodium hydroxide pretreatment induced blueing in *Pezicula acericola* comparable to that induced by KOH, pretreatment with 10% aqueous ammonium hydroxide, 2% aqueous potassium chloride, and 2% aqueous sodium nitrate all failed to induce blueing in the same collection. Though more work clearly needs to be done, it appears that neither the potassium/sodium nor the hydroxide component seems to be completely responsible in the pretreatment for the positive reaction induced by KOH and

NaOH in Melzer's reagent.

CONCLUSIONS

When mounting in Melzer's reagent, four possible consequences of KOH pretreatment, and perhaps other chemical pretreatments, may be anticipated:

(1) Induction of blueing where no blueing occurred with rehydration only in water, as in *Pezicula, Dermea, Chloroscypha,* and perhaps other genera.

(2) Enhancement of an existing reaction. At the Mycological Society of America's Ascomycete Workshop held in August, 1975, at the University of Oregon, after our oral presentation on this topic, J. W. Kimbrough established that in living material the weakly diffuse blueing of the ascus wall in *Iodophanus carneus* (Pers. ex Pers.) Korf when grown in culture is enhanced by KOH pretreatment.

(3) No effect. In many genera which we examined the reaction achieved with KOH pretreatment did not vary from that without pretreatment.

(4) Detraction of the blueing reaction. We have not observed this phenomenon, although we have seen that the amber reaction of the ascus contents in both *Peziza* and *Pachyella* is paler with KOH pretreatment.

The authors hope that in the future taxonomic workers will routinely turn to KOH pretreatment as a check when determining whether a species which appears to be iodine-negative when rehydrated in water is truly iodine-negative. We also caution workers to beware of existing keys that stress the iodine reaction (for example: Dennis, 1956, 1968; Korf, 1972, 1973), since none of these authors have indicated whether they pretreat with KOH or not.

ACKNOWLEDGEMENTS

For the loan of a portion of the type specimen of *Caulocarpa montana,* we express our appreciation to Dr. Amy Y. Rossman, Oregon State University. Miss Martha A. Sherwood, of our laboratory, has assisted us with references to the lichenological literature.

REFERENCES CITED

BRANDT, R.W. 1960. The *Rhabdocline* needle cast of Douglas fir. State Univ. Coll. Forestry, Syracuse Univ., Techn. Publ. 84: 1-66.

DENNIS, R.W.G. 1956. A revision of the British Helotiaceae in the herbarium of the Royal Botanic Gardens, Kew, with notes on related European species. Mycol. Pap. 62: 1-216.

___. 1968. British Ascomycetes. xxxii + 455 p. Cramer, Lehre.

___, & R.P. KORF. 1958. A Japanese species of *Sphagnicola* Velenovsky. Kew Bull. 1958: 181-183.

DUMONT, K.P. 1971. Sclerotiniaceae II. *Lambertella*. Mem. N.Y. Bot. Gard. 22: 1-178.

ERIKSSON, O. 1966. On *Anthostomella* Sacc., *Entosordaria* (Sacc.) Höhn. and some related genera (Pyrenomycetes). Svensk Bot. Tidskr. 60: 315-324.

HALE, M.E., JR. 1974. Morden-Smithsonian expedition to Dominica: the lichens (Theletremataceae). Smithsonian Contr. Bot. 16: 1-46.

KIMBROUGH, J.W. & R.P. KORF. 1967. A synopsis of the genera and species of the tribe Theleboleae (= Pseudoascoboleae). Amer. J. Bot. 54: 9-23.

KORF, R.P. 1962. A synopsis of the Hemiphacidiaceae, a family of the Helotiales (Discomycetes) causing needle-blights of conifers. Mycologia 54: 12-33.

___. 1972. Synoptic key to the genera of the Pezizales. Mycologia 64: 937-994.

___. 1973. Discomycetes and Tuberales. *In* Ainsworth, G.C., F.K. Sparrow & A.S. SUSSMAN [eds.], The fungi: an advanced treatise 4A: 249-319. Academic Press, New York & London.

MINKS, A. 1881. Symbolae licheno-mycologicae 1: i-lxx + 1-176. Theodor Fischer, Kassel.

MÜLLER, E. & R. HÜTTER. 1963. Eine neue Discomycetengattung aus den Alpen, *Neotapesia* nov. gen. Ber. Schweiz. Bot. Ges. 73: 325-331.

MUNK, A. 1957. Danish Pyrenomycetes. Dansk Bot. Ark. 17: 1-491.

PARKER, A.K. & J. REID. 1969. The genus *Rhabdocline* Syd. Can. J. Bot. 47: 1533-1545.

PFISTER, D.H. 1973. The psilopezioid fungi. IV. The genus *Pachyella* (Pezizales). Can. J. Bot. 51: 2009-2023.

POELT, J. 1973. Classification. *In* Ahmadjian, V. & M.E. Hale [eds.], The lichens. pp. 599-632. Academic Press, New York & London.

SÁNCHEZ, A. 1967. The sections *Apostemium* and *Microstemium* of the genus *Vibrissea* (fungi). J. Agric. Univ. Puerto Rico 51: 79-93.

SINGER, R. 1975. The Agaricales in modern taxonomy. Third ed. 912 p. Cramer, Vaduz.

TRAPPE, J.M. 1975. Generic synonyms in the Tuberales. Mycotaxon 2: 109-122.

WEIR, J.R. 1917. A needle blight of Douglas fir. J. Agric. Res. 10: 99-103.

MYCOTAXON

Vol. III, No. 1, pp. 173-181 October-December 1975

STUDIES ON THE LICHEN FAMILY THELOTREMATACEAE. 3.*

Mason E. Hale, Jr.
Department of Botany, Smithsonian Institution
Washington, D.C. 20560

OCELLULARIA CARNEODISCA, sp. nov.

Thallus corticola, epiphloeodes, tenuis, albus, 8-11 cm latus; apothecia semi-emergentia, apice plana, decorticata, carnea, 0.5-0.7 mm diametro; ostiolum irregulare, excipulo interiore projectente, 0.1-0.2 mm diametro; columella nulla; hymenium 100 µm altum; sporae 8:nae, incolores, transversim 4-5 loculatae, 4-5 X 11-14 µm.

Chemistry: No substances present.

Holotype: Virgin dipterocarp forest, Sungei Assan, about 15 km south of Sibu, Sarawak, elev. 1-2 m, *M. E. Hale* 30409, 11 March 1965 (US) (Figure 1).

This species has an apical structure similar to that in *O. lopezii* Hale (see below) but is at most only pruinose rather than pulverulent. The pale reddish flesh-colored apical area contrasts sharply with the light ashy thallus when viewed with low power magnification. The pore is round or may appear only as an irregular fissure.

OCELLULARIA GROENHARTII, sp. nov.

Thallus corticola, epiphloeodes, nitidus, viridi-albus, 8-10 cm latus; apothecia semi-emergentia, 0.8-1.2 mm diam-

---

*All chemical tests were done with thin-layer chromatography in two solvent systems (hexane-ether-formic acid and benzene-dioxane-acetic acid) with development in H_2SO_4. Contribution No. 1 in this series was published in *Phytologia* 26:413-420, 1973, and No. 2 in *Phytologia* 26:490-501, 1973.

etro; ostiolum rotundatum, 0.2-0.3 mm diametro, plus minusve albocinctum; columella evoluta, ca. 180 µm diametro; hymenium 160 µm altum; sporae 4:nae vel 8:nae, incolores, transversim 15-20 loculatae, 8-14 X 60-80 µm, I+ coerulescentes.

Chemistry: "Olivacea" and "chonestoma" unknowns.

Holotype: Bay of Nglijep, South Malang, Java, elev. 5 m, *P. Groenhart* 502, 21 August 1932 (L; isotype in US).

Additional specimens examined. Solomon Islands: Guadalcanal, *Hill* 8022 (BM, US). India: Kerala, Wyanad Forest, *Patwardhan and Nagarkar* 73.2777 (Poona, US) (Figure 2).

The thallus of this species is typically greenish and shiny. The ascocarps are numerous with a large depressed pore, within which the more or less white pruinose apex of the columella is visible. The two unknown P- substances are identical with those in *O. chonestoma* (Lgt.) Zahlbr., which has smaller, more emergent apothecia and small spores (about 25 µm long). *Ocellularia nylanderiana* Hale has a thicker, granular thallus and emergent ascidioid apothecia. *Ocellularia groenhartii* occurs widely in Asia at low elevations (100-400 m). It is named in honor of Dr. P. Groenhart, who contributed so much to our knowledge of tropical Asian lichens.

OCELLULARIA LOPEZII, sp. nov.

Thallus corticola, hypophloeodes, 8-12 cm latus; apothecia aggregata, semi-emergentia, 0.3-0.5 mm diametro, alba, decorticata, pulverulenta; ostiolum rotundatum, 0.05 mm diametro; columella nulla; hymenium 120 µm altum; sporae 8:nae, incolores, transversim 4-loculatae, 5 X 15 µm.

Chemistry: Psoromic and conpsoromic acids.

Holotype: Remnants of cloud forest, La Carbonera, Estado Mérida, Venezuela, elev. 2200 m, *M. E. Hale* 44138, 19 March 1975 (US) (Figure 3).

The clustered apothecia remind one of a *Trypethelium* but the apical area is decorticate and a distinct pore is visible. There are no comparable species in the genus, excepting perhaps *O. carneodisca* Hale described above. It is named in honor of Dr. M. Lopez-Figueiras of the Universidad de los Andes, whose generous support and assistance in my field studies in Venezuela is gratefully acknowledged.

OCELLULARIA MAURETIANA, sp. nov.

Thallus corticola, epiphloeodes, nitidus, verruculosus, aetate rimosus, ca. 6 cm latus; apothecia emergentia, irregulariter aggregata, basin constricta, 1.5-3.0 mm diametro, amphithecio corticato, verruculoso; ostiolum apertum, 0.5-2.0 mm diametro, disco late actinoideo-diviso; hymenium 120 µm altum; sporae 8:nae, incolores, transversim 4-6 loculatae, 8-10 X 15-18 µm, I+ coerulescentes.

Chemistry: Protocetraric acid.

Holotype: Ponce, Mauretius, *Dr. Ayres* (BM; isotype in US) (Figure 4).

The apothecia are very large and in part aggregated and anastomosing. The disc is partially actinoid but with very weak carbonization. It seems unrelated to any other species of *Ocellularia* containing protocetraric acid. It is probably endemic to the wet higher forests still remaining on Mauretius.

PHAEOTREMA FOLIICOLA, sp. nov.

Thallus foliicola et muscicola, epiphloeodes, tenuis, viridi-albus, 6-8 cm latus; apothecia vix emergentia, 3-5 mm diametro; ostiolum rotundatum, 0.1-0.2 mm diametro, albocinctum; columella nulla; hymenium ca. 80 µm altum; sporae 8:nae, obscurae, transversim 4-5 loculatae, 10 X 20 µm.

Chemistry: Psoromic and conpsoromic acids.

Holotype: Kolombangara Island, Solomon Islands, elev. 2600-2800 ft., *D. J. Hill* 10525, 3 September 1965 (BM; isotype in US) (Figure 5).

No other species in *Phaeotrema* with psoromic acid have immersed apothecia. The foliicolous habit over mosses may be obligate, but very few foliicolous species in the family, outside of *Chroodiscus*, are known.

PHAEOTREMA STICTICUM, sp. nov.

Thallus corticola, epiphloeodes, cinereo-albus, 10 cm latus; apothecia emergentia, basin leviter constricta, 0.7-1.0 mm diametro, apice decorticata, minute pulverulenta; ostiolum rotundatum, 0.2-0.4 mm diametro; columella evoluta, ca. 200 µm diametro, apice pruinosa; hymenium ca. 140 µm altum; sporae 8:nae, obscurae transversim 4-6 loculatae, 8-10 X 18-24 µm.

Chemistry: Stictic acid.

Holotype: Mist forest, Pico Avila, Distrito Federal, Venezuela, elev. ca. 2000 m, *M. E. Hale* 43391, 9 February 1974 (US) (Figure 6).

The apothecia have a broad pore filled with the pruinose columella apex. The rim is thick and uneven, lightly pruinose but lacking any raised margin. There are no similar stictic acid-containing species in the genus.

THELOTREMA CONFERENDUM, sp. nov.

Thallus corticola, epiphloeodes, tenuis, olivaceo-albus, 6-8 cm latus; apothecia immersa vel semi-emergentia, 0.7-1.1 mm diametro, excipulo interiore distincto; ostiolum latum, 0.4-0.5 mm diametro; columella nulla; hymenium ca. 250 µm altum; sporae 1-2:nae, incolores, 25-35 X 100-140 µm, multiloculares, I-.

Chemistry: Stictic and constictic acids.

Holotype: On trees in open places in montane rain forest, Mount Gallego, Guadalcanal Island, *D. J. Hill* 8180, 7 July 1965 (BM; isotype in US) (Figure 7).

Externally this species is identical with *Ocellularia exanthismocarpa* (Lgt.) Zahlbr., especially with regard to the distinct inner exciple which forms a kind of double pore with the main apothecial rim. The spores, however, are muriform, larger than the transversely septate spores of *O. exanthismocarpa*, and negative with iodine.

THELOTREMA EITENII, sp. nov.

Thallus corticola, epiphloeodes, tenuis, albidus, 6-8 cm latus; apothecia sessilia, orbicularia vel elongata, 1.0-1.5 mm diametro, margine erecto, crasso, recurvo, disco aperto, plano, dense pruinoso; columella nulla; hymenium 100-120 µm altum; sporae 1-2:nae, incolores, 25-30 X 80-100 µm, multiloculares.

Chemistry: Protocetraric acid.

Holotype: 2 Km west of Ouro Preto, Minas Gerais, Brazil, elev. 1200 m, *G. Eiten* 6961, 28 November 1965 (US) (Figure 8).

This species has a typical chroodiscoid apothecium. The main exciple is quite thick, as in *Ocellularia dilatata* Müll. Arg., and the open disc is heavily pruinose. *Thelotrema leprocarpum* Tuck. and *T. colobolicum* Nyl. are similar in spore size but both are smaller species lacking any lichen substances.

THELOTREMA EMINENS, sp. nov.

Thallus corticola et muscicola, epiphloeodes, cinereo-albus, 4 cm latus; apothecia valde emergentia, eminentia, cylindrica, ca. 0.4 mm diametro, 0.4-0.5 mm alta, omnino corticata; ostiolum rotundatum, 0.1-0.2 mm diametro, depressum; columella nulla; hymenium ca. 200 µm altum; sporae 1-2:nae, 70-80 X 150-170 µm, multiloculares.

Chemistry: Stictic and constictic acids.

Holotype: Mossy oak forest, Gunong Brinchang, Pahang, Malaya, elev. 2000 m, *M. E. Hale* 29947, 3 March 1965 (US) (Figure 9).

The tall cylindrical apothecia are similar to those in *T. tuberculiferum* Vainio except that the apical area is entirely corticate. It is also unusual in producing stictic acid, for most of the large-spored species in this group contain no lichen substances.

THELOTREMA INDICUM, sp. nov.

Thallus corticola **et** muscicola, tenuis et pro parte hypophloeodes, albidus, 6-10 cm latus; apothecia emergentia, prominentia, 0.4-0.6 mm diametro, alba, primo verruciformia, aetate pulverulenta, pro parte radiato-divisa, apice fuliginea; ostiolum rotundatum, 0.2-0.3 mm diametro; columella nulla; hymenium ca. 200 µm altum; sporae 1-2:nae, 25-

36 X 80-120 µm, multiloculares, I+ coerulescentes.

Chemistry: No substances present.

Holotype: On *Cupressus* along road to Dodapetta, Tamil Nadu, India, elev. 2600 m, *M. E. Hale and P. G. Patwardhan* 40185, 8 November 1973 (US; isotype in Poona) (Figure 10).

This species was common on planted roadside cypress trees. The apothecia are completely decorticate at maturity and lack carbonization. It belongs in the *T. tuberculiferum* group and is differentiated by the smaller spores and apothecia.

THELOTREMA ISIDIATUM, sp. nov.

Thallus corticola vel muscicola, tenuis, pro parte hypophloeodes, viridi-albus, 4-6 cm latus, modice vel dense isidiatus, isidiis simplicibus vel ramosis, fragilibus, ca. 0.5 mm altis; apothecia valde emergentia, alba, basin constricta, ca. 0.5 mm diametro, pro parte isidiata, superne pulverulenta, apice fusca; ostiolum rotundatum, 0.2-0.3 mm latum; columella nulla; hymenium 200 µm altum; sporae 1-2:nae, 30-40 X 120-150 µm, multiloculares.

Chemistry: No substances present.

Holotype: Area of small trees in paramo, Páramo La Negra, Mérida, Venezuela, elev. 2900 m, *M. E. Hale* 42425, 2 February 1974 (US) (Figure 11).

Additional specimen examined. Venezuela: Mossy tree in cloud forest, Pico Avila, Distrito Federal, Venezuela, elev. 2000 m, *Hale* 43382 (US).

Thelotrema isidiatum is distantly related to the *T. tuberculiferum* and *T. decorticans* Müll. Arg. group because of the strongly emergent, almost globose apothecia which become white-pruinose apically, but the black ascocarp wall is still visible beneath the pruina. The isidia are often branched and rather fragile with a minutely roughened surface, not smooth and corticate as in *T. insigne* Zahlbr., for example, which has noncarbonized apothecia and contains psoromic acid.

THELOTREMA MERIDENSE, sp. nov.

Thallus corticola, epiphloeodes, pallide viridis, 4-5 cm latus; apothecia emergentia, primum orbicularia sed aetate stellata, 0.4-0.7 mm diametro, superne ambitu decorticata et pulverulenta, alba, radiato-divisa; ostiolum discretum, 0.05-0.1 mm diametro; columella nulla; hymenium 140 µm altum; sporae 2-4:nae, incolores, 17-20 X 65-75 µm, 1-2 X 12-15 loculatae.

Chemistry: Stictic and constictic acids.

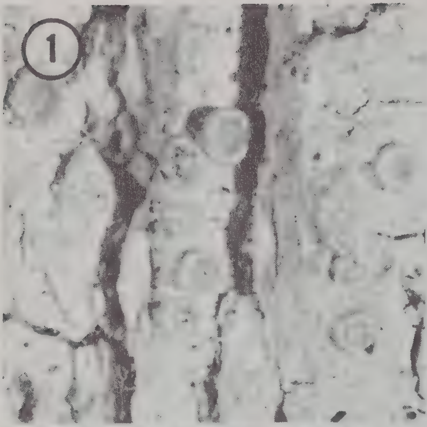
Holotype: Near base of large tree in dense cloud forest, trail between La Montaña and La Aguada, Teleférico, Mérida, Venezuela, elev. 2600 m, *M. E. Hale* 46104, 13 April 1975 (US; isotype in Mérida) (Figure 12).

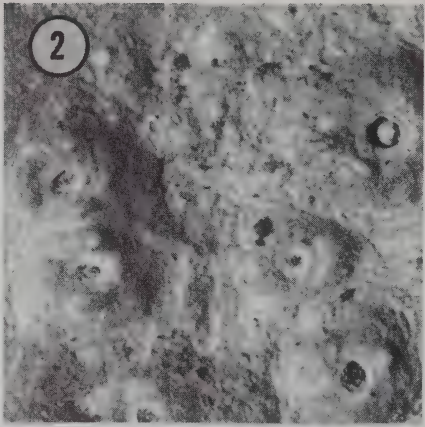
This remarkable species is unique in having star-shaped apothecia. The young apothecia are initially orbicular with a decorticate apex. The amphithecium soon becomes radially rugose and finally grotesquely star-shaped. The apical area has a pulverulent, almost sorediate-granular surface. This is the only apically decorticate species with stictic acid.

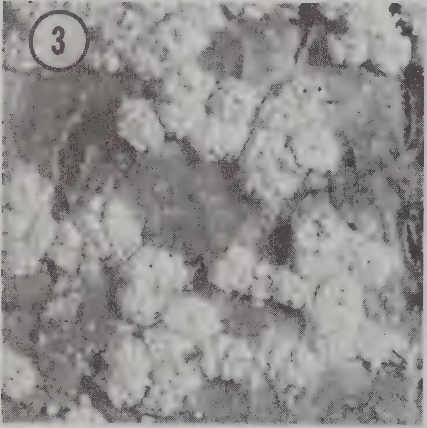
LEGENDS FOR THE PLATES

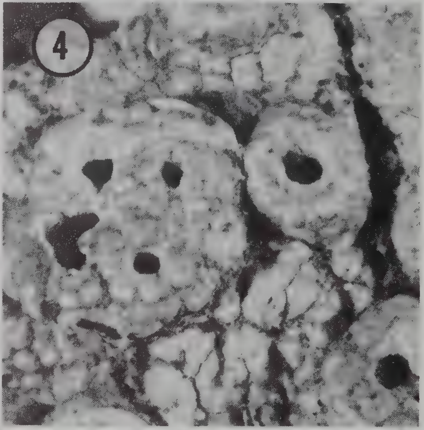
Figures 1-6. Specimens of Thelotremataceae: 1, *Ocellularia carneodisca* Hale (*Hale* 30409); 2, *O. groenhartii* Hale (*Patwardhan and Nagarkar* 73.2777); 3, *O. lopezii* Hale (*Hale* 44138); 4, *O. mauretiana* Hale (*Ayres*); 5. *Phaeotrema foliicola* Hale (*Hill* 10525); 6, *P. sticticum* Hale (*Hale* 43391). All specimens about X10.

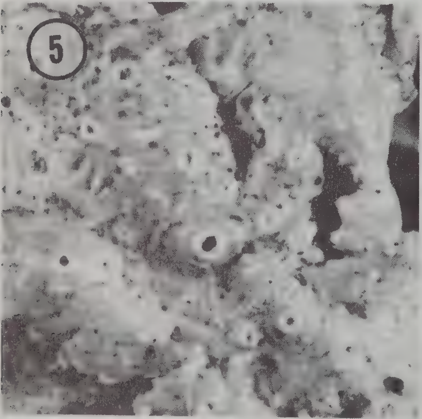
Figures 7-12. Specimens of Thelotremataceae: 7, *Thelotrema conferendum* Hale (*Hill* 8180); 8, *T. eitenii* Hale (*Eiten* 6961); 9, *T. eminens* Hale (*Hale* 29947); 10, *T. indicum* Hale (*Hale and Patwardhan* 40185); 11, *T. isidiatum* Hale (*Hale* 42425); 12, *T. meridense* Hale (*Hale* 46104). All specimens about X10.

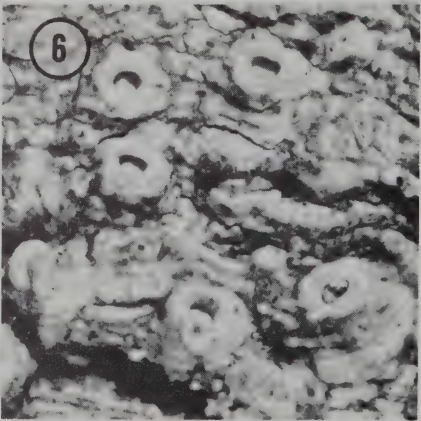

1

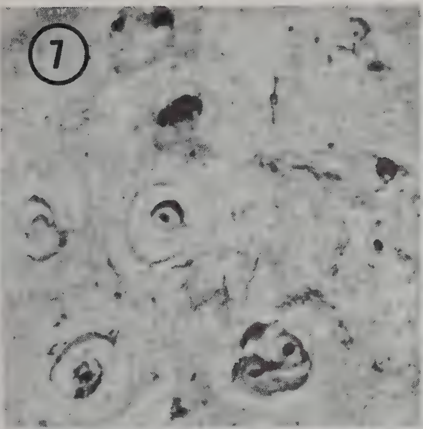

2

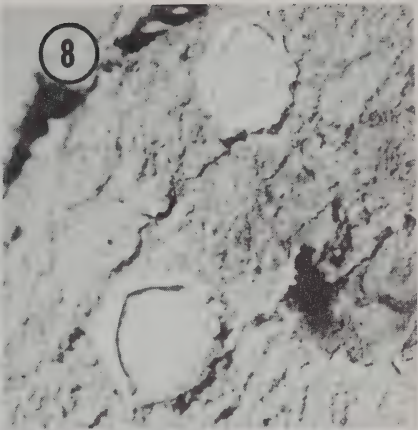

3


4

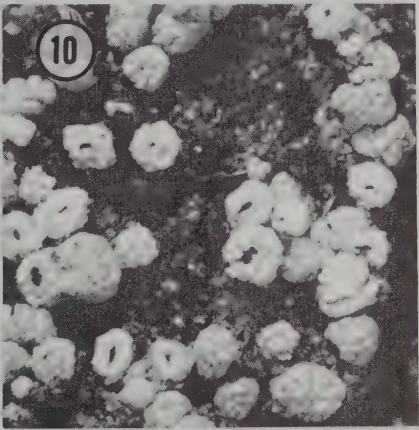

5

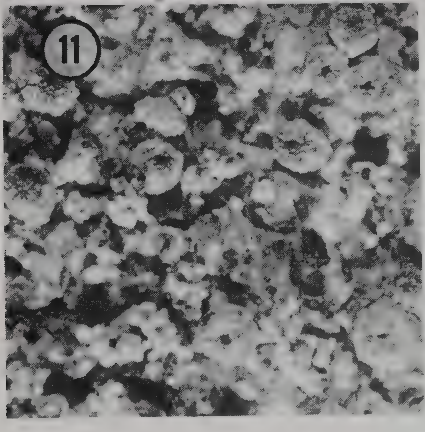

6

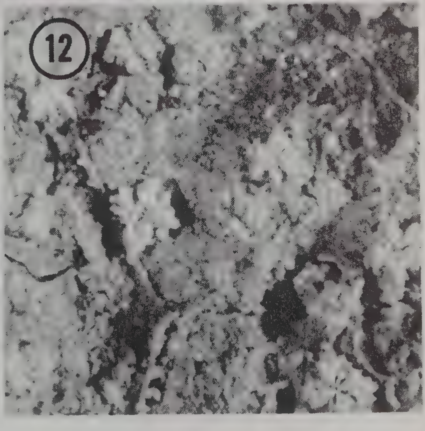

⑦


⑧

⑨


⑩


⑪


⑫

MYCOTAXON

Vol. III, No. 1, pp. 182-184 October-December 1975

BOOK REVIEWS

by

G. L. HENNEBERT

Book Review Editor, Huttelaan 36, B-3030 Heverlee, Belgium

DIAGNOSTIC DE LABORATOIRE EN MYCOLOGIE MEDICALE, by G. SEGRETAIN, E. DROUHET and F. MARIAT, 3rd ed., 144 p., 35 fig., 13.5 × 21 cm, glued paperbound, 1974, Collection "Techniques de Base," Maloine s.a., 27 rue de l'Ecole de Médecine, 75006 Paris. FF 40.-

Professors at the Pasteur Institute in Paris and responsible for the same, the authors of this presentation of new techniques intend to make easier the diagnosis of the mycoses and the identification of the pathogenic fungi. The practicioner will find information on the methods of sampling, staining or isolating the fungi as well as on the establsihment of the immunological, physiological or pathogenic characteristics of the fungi. Specific methods in the study of the cutaneous, subcutaneous and deep mycoses are detailed in the second half of the manual. Special attemtion is given to the identification of *Trichophyton* and *Candida* species. One can only regret that the nomenclature of the fungi is not brought up to date.

THE FUNGI OF PUERTO RICO AND THE AMERICAN VIRGIN ISLANDS, par John A. STEVENSON, Contribution of the Reed herbarium No. 23, 743 p., 15 × 23 cm, paperbound, 1975, 10105 Harford Rd., Baltimore, Md., US $6.80.

Cet ouvrage est certainement une contribution majeure à la flore mycologique de Porto Rico et des Iles Vierges. Il remplace avantageusement le premier relevé de la même flore publié par l'auteur en 1918 et qui déjà comprenait 1025 espèces. Le présent ouvrage compile en effet une flore de 2300 espèces et 30 variétés, résultat de 160 années de récoltes et d'etudes. On y trouve associés des grands noms, tels Klotsch, Cook, Bresadola, Lloyd, Earle, Stevens, Ashford, Fawcett, Arthur, Johnson, Petrak, Seaver, Chardon, Carrion, Whetzel, Olive, Kern, Toro. La liste des espèces suit un ordre taxonomique et une nomenclature aussi moderne que possible, l'auteur s'étant efforcé de tenir compte de la plus récente littérature et au besoin d'établir des combinaisons nouvelles. Chaque espèce est citée avec référence et synonymie, sans description mais avec un commentaire sur les hôtes, l'habitat et la distribution géographique.

THE BOLETI OF NORTH CAROLINA, par W. C. COKER et Alma H. BEERS, 96 p., 66 pl. (6 en couleurs), 15.5 × 23.5 cm, broché. Dover Publ., 180 Varik St., New York, NY 10014. US $ 3.50.

Cet ouvrage, un des classiques sur les Bolets, est la réimpression de l'ouvrage original "The Boletaceae of North Carolina" publié en 1943 par the University of Carolina Press. 68 espèces de *Boletus*, genre pris au sens large, 4 de *Boletinus* et 1 de *Strobilomyces* sont décrites. Si le titre de l'ouvrage a été modifié, on s'étonnera de trouver un contenu inchangé, dans le même style traditionel, où même les termes "plant" et "stem" n'ont pas été remplacés par "carpophore" et "stipe."

THE GENERA OF FUNGI SPORULATING IN PURE CULTURE, by J. A. von ARX, 2nd ed., 315 p., 134 fig., bound, 1974. J. Cramer & A. R. Gantner Vg., FL-9490 Vaduz, Liechtenstein. DM 100.-

A fully revised edition of the book published in 1970. More than 780 fungus genera, versus 635, are included now, with full reference, type species, conidial or sexual state and important literature. The fungi covered are the Lower Fungi, the Ascomycetes and the Fungi Imperfecti. Dichotomous keys and line drawings are provided as guides to the identification. A very helpful book for mycologists, microbiologists, plant pathologists.

METODE ŞI TEHNICI ÎN MICOLOGIE, par Ovidiu CONSTANTINESCU, 214 p., 31 fig., 24 × 17 cm, relié, 1974. Ed. Ceres, Bucarest. Lei 18.

L'auteur décrit les méthodes d'études des champignons, méthodes de récolte, d'isolement, d'éxamen microscopique, de culture et de conservation. Le contenu, qui est detaillé et bien illustré, se base sur plus de 1000 publications. Plus de 200 formules de milieux de culture sont données avec leurs variantes, préparation et applications. Ouvrage très utile à tout laboratoire de mycologie, de phytopathologie et de microbiologie, mais en roumain.

MOISISSURES TOXIQUES DANS L'ALIMENTATION, by Claude MOREAU, 2nd ed., 480 p., 31 fig., 16 × 24 cm, cloth bound, 1974. Masson & Cie., Paris. FF 180.-

Not only wild mushrooms but many of the microscopic moulds are toxic. An exact knowledge of each fungus and of its toxicity is today more important than ever. The book is an expanded and up to date edition of the original version published in 1968. Because of the abundant data, emphasis is given to the toxicoses by *Aspergillus flavus* and *Penicillium islandicum*, but fungus characteristics and toxin detection, properties and action are given for many other species of *Aspergillus*, *Penicillium*, *Fusarium*, *Pithomyces*, *Stachybotrys*, *Mucor*, *Rhizopus*, *Byssochlamys*, *Chaetomium*, *Cladosporium*, *Wallemia*, *Trichothecium*, *Gliocladium*, *Trichoderma*, etc.

A REEVALUATION OF THE BITUNICATE ASCOMYCETES WITH KEYS TO FAMILIES AND GENERA, par J. A. von ARX et E. MULLER, *in* Studies in Mycology, n° 9, 159 p., 66 fig., 15.5 × 24 cm, broché, 1975. Centraalbureau voor Schimmelcultures, Baarn. HFl 30.-, souscription annuelle HFl 40.-.

Tous les genres d'ascomycètes bituniqués connus des auteurs sont repris dans 34 familles et forme l'ordre unique des Dothideales. Chaque famille est décrite avec ses caractéristiques, ses affinités et sa synonymie. Les genres reconnus sont donnés avec référence, espèce-type, espèces principales, genres synonymes, stades conidiens et hôtes. Nombreuses sont les nouvelles combinaisons proposées suite aux nouvelles synonymies. Les auteurs reconnaissent dans cette étude la fragilité des caractères admis comme fondamentaux. Plutôt que de réaffirmer une classification phylogénique incertaine, ils ont choisi une subdivision en famille basée sur des caractères aisément observables. Cette intéressante classification, pragmatique mais claire, des Bituniqués aura certainement la faveur de ceux qui ceulent efficacement aborder ce groupe.

ON THIELAVIA AND SOME SIMILAR GENERA OF ASCOMYCETES, par J. A. von ARX, *in* Studies in Mycology, n° 8, 31 p., 4 fig., 3 pl., 15.5 × 24 cm, broché, 1975. Centraalbureau voor Schimmelcultures, Baarn. HFl 10.-.

Le genre *Thielavia* Zopf pris au sens large couvre un groupe hétérogène de champignons dans lequel l'auteur met un ordre nouveau. Il y reconnaît 10 genres, dont deux nouveaux, *Melanocarpus* v. Arx et *Corynascella* v. Arx & Hodges, sur la base de la forme et du nombre des pores germinatifs, la nature fine ou épaisse des parois ascomatales à texture épidermoïde ou parenchymateuse, le caractère pileux des ascomata et la nature du stade conidien.

DIFFERENCIATION FONGIQUE, by G. TURIAN, *in* Monographies de Physiologie végétale, by P. E. PILET, ed., vol. 5, 144 p., 30 fig., 2 pl., 10 tab., 16.5 × 21.5 cm, paperbound, 1969. Masson & Cie., Paris. FF 50.-.

No publication has compiled all the available data on the biochemical mechanisms of morphogenesis in the fungi. The work of G. Turian has been a major step in that way. A very interesting emphasis is given to the dimorphism yeast/hypha in yeasts and other fungi and to the sexual/conidial sporulation in *Neurospora*. The author demonstrates the dependence or independence of the fungi on their chemical environment. These data are susceptible to enlighten the behavior of fungi in artificial culture.

MYCOTAXON

Vol. III, No. 1, pp. 185-192 October-December 1975

COMMENTS ON THE SCLEROMYCETI SUECIAE IN THE FARLOW HERBARIUM

Donald H. Pfister

The Farlow Reference Library and Herbarium of Cryptogamic Botany and the Biology Department, Harvard University

Holm and Nannfeldt (1962) have given an excellent account of Fries's *Scleromyceti Sueciae*. In compiling their information they relied heavily on the herbaria at Uppsala (U), Kew (K), Paris (PC), and Beltsville (BPI). Considering the importance of the exsiccata and in cognizance of irregularities involved in its publication, discussion of its representation in other herbaria seems worthwhile. The following account deals with the three sets of this exsiccata located in the Farlow Herbarium.

A letter in which L. C. Shear mentioned that decades 1-8 of the exsiccata are present in the Farlow Herbarium is quoted by Holm and Nannfeldt (1962). However, there is no published account which indicates that other specimens from this exsiccata are present in the Farlow collections. The set mentioned by Shear, except for the absence of specimen nos. 185-274, is complete and is mounted in its original booklet form. But besides that set there is also an incomplete set containing only 47 specimens. These specimens, apparently received on loose sheets and mounted locally in a single book, were purchased from Jean Étienne Duby, a 19th century cryptogamist and accumulator of specimens, by William Gilson Farlow in October 1879. Unfortunately, search through the Duby-Farlow correspondence discloses no information about Duby's source of these specimens.

As Holm and Nannfeldt pointed out there are two editions of the exsiccata. Specimens of the first edition, at least those in fascicles 1-8, were mounted in small books with title pages and indices. The second edition was not uniformly prepared (some labels having been handwritten or corrected) and involved numbers 1-300 (fascicles 1-8) and those of higher numbers. Fascicle 9 presents a number of questions. Holm and Nannfeldt believe it was never issued in booklet form and that the specimens composing it may never have been issued together.

Of the Farlow collections there is no question that the set mounted in booklets is of the first edition. In my opinion, the specimens from Duby were also derived from the first edition. This opinion is supported by the following observations. First, although the 47 specimens are not mounted in booklets the paper to which they are glued is the same as that of the bound copy. The watermarks, texture, and color agree between the two. Second, the specimens are mounted in the same general manner. This is especially evident in those cases where two specimens were mounted on a single page. Also, some of the sheets have obviously been folded along one edge as if they were removed from booklets. Third, although some of the sheets are annotated there are no nomenclatural changes in Fries's handwriting or in that of the "secretary's" (see Holm and Nannfeldt, fig. 3) as is common in the second edition.

In neither of the two W. G. Farlow sets mentioned above are there numbers from the ninth fascicle (300-340) or any above 340. However, numbers from the ninth fascicle as well as some above 340 have been found in the Curtis herbarium. This set though containing only 209 specimens is interesting because it amplifies, verifies, and clarifies some of the information given by Holm and Nannfeldt. The following discussion is based on this material.

Fries's Scleromyceti Sueciae in the Curtis Herbarium

Information, in Curtis's hand, on the packets of a number of specimens from this exsiccata in the Curtis herbarium indicate that the specimens were sent by Fries. Unfortunately, all of these specimens have been drastically remounted. The specimens were removed from the original sheets as were the original labels. Both labels and specimens were reglued to small sheets apparently by Curtis. He then annotated the sheet, generally making a drawing of some microscopic feature, usually spores. It is impossible to determine in what form the original specimens were received. They were undoubtedly sent to Curtis sometime after the originals were distributed. There also are a number of miscellaneous specimens in the Curtis herbarium which, though not a part of the exsiccata, were sent by Fries. According to Shear and Stevens (1919) Curtis did not seriously engage in mycological studies until 1845 or 1846. It would have been unlikely for him to have exchanged specimens earlier. According to Holm and Nannfeldt fascicle nine of the *Scleromyceti Sueciae* may have been published in 1825 and the entire second edition must have been completed by 1841. It is not surprising then that the Curtis set is incomplete nor that there are a large number of specimens from the second edition (that is, those easily distinguished on the basis of handwritten labels).

Of 143 specimens from the first 8 fascicles only a few warrant comment, which follows.

8b - *Sphaeria ambiens* - Holm and Nannfeldt did not list the existence of this number. Number 8 is also *Sphaeria ambiens*. Whether this notation indicates that Fries attempted to denote a new collection of the species or a new concept of the species remains an unresolved question. The label is handwritten. There is also a printed label for another specimen of number 8.

26 - *Sphaeria tubeformis* - The label is handwritten. The spelling as listed here is as it appears on this label. Holm and Nannfeldt have it as "*tubaeformis*."

48 - *Sphaeria filicina* - The label is handwritten, undoubtedly a second edition specimen.

71 - *Sphaeria disciformis* - Two specimens are present; one with a printed label and one handwritten.

73 - *Sphaeria lanciformis* - The label is handwritten.

88 - *Sphaeria excipuliformis* - The handwritten label reads *Sphaeria*; other specimens from the original edition with printed labels read *Lophium*.

95 - *Stictis parallela* - In the original edition this was issued under *Hysterium*.

102 - *Tympanis frangulae* - The label is handwritten.

104 - *Sphaeronema hemisphaeria* - The label is handwritten by Fries.

112B - *Sphaeria lejoplaca* - This is one of the second edition specimens issued under this name rather than under *Sphaeria lata* as in the original edition. According to Holm and Nannfeldt other second edition specimens of this number are located in K and PC.

119 - *Sphaeria abducens* - This is a second edition specimen but apparently does not agree with the one cited by Holm and Nannfeldt in Kew since it is not labeled *Sph. abducens minor*.

162 - *Sphaeria mutilaria* - A handwritten label by Fries.

187 - *Sphaeria ocellata* β - This handwritten label is at variance with the printed label which reads *S. tessella* in the first edition. Holm and Nannfeldt state that there is a specimen, labeled as listed above, in PC.

226 - *Sphaeria prunastri* - The label is handwritten.

229b - *Sphaeria suffusa* - Holm and Nannfeldt do not record this number. This presents the same problem as 8b.

230B - *Sphaeria nucula spuria F. platystoma* - Holm and Nannfeldt point out that this was probably meant to be 238 but that due to a misprint in SM and Fries's own errors in writing subsequent labels the error became entrenched.

242 - *Sphaeria fimbriata* - A handwritten label.

295 - *Ditiola radicata* - The Curtis specimen was apparently received from de Notaris; the label bears his seal and is in his hand.

In table 1, I have listed those numbered specimens in the Curtis herbarium bearing numbers above 300. The few to which I can add comment are listed below; these are marked with an asterisk in the table.

315 - *Sphaeria vibratilis* - There are two examples bearing this number. One is a printed label with the name *Sphaeria vibratilis* as listed by Holm and Nannfeldt.

TABLE 1

306 - *Sphaeria favacea*
307 - *Sphaeria spiculosa*
308 - *Sphaeria dothidea*
*315 - *Sphaeria vibratilis*
317 - *Sphaeria pupula* β *philadelphi*
318 - *Sphaeria strobilina*
*319 - *Sphaeria semitecta*
*320 - *Sphaeria arbuticola*
321 - *Sphaeria doliolum*
324 - *Sphaeria uda*
325 - *Sphaeronaema subulatum*
*326 - *Phacidium rugosum* β
*328 - *Dothidea asteroma*
332 - *Peziza flammea*
334 - *Peziza resinae*
342 - *Sphaeria bullata*
345 - *Sphaeria macrostoma*
346 - *Sphaeria cirrhosa*
347 - *Sphaeria uberiformis*
348 - *Sphaeria alligata*
*349 - *Sphaeria lonicerae*
*351 - *Lophium aggregatum*
*358 - *Leptostroma spiraeae var. rubi*
369 - *Phacidium patella*
381 - *Sphaeria fibrosa*
*382 - *Sphaeria omalogramma*
383 - *Sphaeria prorumpens* β
384 - *Sphaeria thelebola*
385 - *Sphaeria mutila* β
386 - *Sphaeria tristis*
387 - *Sphaeria mammaeformis*
388 - *Sphaeria applanata*
389 - *Sphaeria pertusa*
390 - *Sphaeria brevirostris*
391 - *Sphaeria corticis*
392 - *Sphaeria cerasorum a*
*393 - *Sphaeria cerasorum b*
394 - *Sphaeria inquinans*
397 - *Sphaeria mammillana minor*
398 - *Sphaeria clypeata*
399 - *Sphaeria oppilata*
*401 - *Sphaeria calvescens*
404 - *Sphaeria galii*
*405 - *Sphaeria caulium*
406 - *Sphaeria lirella*
*407 - *Sphaeria deplanata*
408 - *Sphaeria complanata* β *minor*
409 - *Sphaeria corni suecicae*
*410 - *Sphaeria salicina*
412 - *Phacidium shizoxylon*
417 - *Eustegia ilici*
420 - *Excipula punctiformis*
423 - *Eustegia robertiani*
430 - *Dermea cerasi*
437 - *Phragmotrichum aceriunum*
439 - *Conoplea olivacea*
441 - *Sphaeria melogramma*
*442 - *Sphaeria stellulata*
*443 - *Sphaeria lejoplaca* β
444 - *Sphaeria xanthostroma*
*447 - *Sphaeria diminuens*
*448 - *Sphaeria eutypa var.*
449 - *"Sphaeria rigida"*
*451 - *Peziza sanguinea*
*458 - *Sphaeria craterium*

The other is a handwritten label (in Fries's hand) which bears the name *Sphaeria stricta* var. This latter species was issued as 314, the handwritten label is apparently a *lapsis calimi.*

319 - *Sphaeria semitecta* - A handwritten label.

320 - *Sphaeria arbuticola* - A handwritten label.

326 - *Phacidium rugosum* β - Holm and Nannfeldt indicate that in the first edition this was called *Dothidea vaccini* and indicate a confusion with number 353. The Curtis specimen is as listed above and is clearly numbered 326.

328 - *Dothidea asteroma* - Holm and Nannfeldt point out the confusion about this number. In our collection the label is damaged and only "28" is print; the "3" is in hand.

349 - *Sphaeria loniceri* - The label is handwritten but lacks a number. The label was annotated, apparently by Curtis with "349?"

351 - *Lophium aggregatum* - An annotation on the Curtis specimen by M.L. Lohman reads "351 *Lophium aggregatum* Fries Sel. Suec. 1836' in Duby Herb. at Strasbourg, wood is coniferous - not oak as Rehm stated."

358 - *Leptostroma spiraeae var. rubi* - The label is as indicated by Holm and Nannfeldt.

382 - *Sphaeria omalogramma* - Holm and Nannfeldt report only a specimen in BPI.

393 - *Sphaeria cerasorum* β - Holm and Nannfeldt list K and PC as the herbaria in which this number was located.

401 - *Sphaeria caevescens* - Holm and Nannfeldt list K and PC as also having a specimen under this number.

405 - *Sphaeria caulium* - as above.

407 - *Sphaeria deplanata* - Holm and Nannfeldt discuss the problems related to the confusion over this species. The specimen in the Curtis herbarium bears the name *Sphaeria deplanata* Fr. but this is annotated in pencil

SEE ERRATA

(by Curtis ?) so that it reads *"complanata"*.

410 - *Sphaeria salicina* - Holm and Nannfeldt state that the only specimen located was in K.

442 - *Sphaeria stellulata* - The only other material reported is in K and PC.

443 - *Sphaeria lejoplaca* β - The only other material reported is in K, BPI, and PC.

446 - *Sphaeria picea* - The specimen has a printed and corrected label obviously taken from no. 194.

447 - *Sphaeria diminuens* - There are two specimens with this number. One specimen has a printed, corrected label taken from no. 15 of the original edition. This corrected label reads *Sphaeria eutypa* var. The varietal name is given but I was unable to decipher the name. *Sphaeria eutypa* is listed by Holm and Nannfeldt as no. 448 but without reference to the varietal name. Another specimen in the Curtis collection numbered 447 has a handwritten label which reads *Sphaeria diminuens*. This agrees with the name Holm and Nannfeldt have given for number 447. The label with the name *Sphaeria eutypa* var. is probably a *lapsis calami* and should read 448. Material of *Sphaeria diminuens* number 447 was seen by Holm and Nannfeldt at K and PC.

448 - *Sphaeria eutypa* - The only material with this name is the misnumbered specimen discussed above. Holm and Nannfeldt have apparently seen material properly numbered at K.

451 - *Peziza languinea* - The only material listed by Holm and Nannfeldt is in K.

458 - *Sphaeria craterium* - The label on the specimen in the Curtis herbarium reads *"Sphaeria craterium"* Dec. The accepted name, however, that was used in Summa Veg. Scand. was *Trochila craterium*.

Literature Cited

Holm, L., and J.A. Nannfeldt. 1962. Fries's "Scleromyceti Sueciae" a study on its editorial history with an annotated check-list. Friesia 7: 10-59.

Shear, C.L., and N.E. Stevens. 1919. The mycological work of Moses Ashley Curtis. Mycologia 11: 181-201.

Y
0
92
3
2

MYCOTAXON

AN INTERNATIONAL JOURNAL DESIGNED TO EXPEDITE PUBLICATION
OF RESEARCH ON TAXONOMY & NOMENCLATURE OF FUNGI & LICHENS

Vol. III January-March 1976 No. 2

CONTENTS

Siemaszkoa and *Botryandromyces*, two segregates of *Misgomyces* (Laboulbeniales). ISABELLE I. TAVARES AND TOMASZ MAJEWSKI 193

Taxonomy, morphology and ontogeny of *Gelatinodiscus flavidus*.......................... STEVEN E. CARPENTER 209

The genus *Platysticta*.......... MARTHA A. SHERWOOD 233

Specific and infraspecific names for fungi used in 1821. Part III. D-G........... RONALD H. PETERSEN 239

Boletes of the southwestern United States. HARRY D. THIERS 261

Notice: MYCOTAXON policy on arguments supporting proposals on nomina generica conservanda.......... 274

Species of *Lycoperdon* with a setose exoperidium. V. DEMOULIN 275

Myxomycetes of Mexico I. KARL LEO BRAUN AND HAROLD W. KELLER 297

Book Review............................ G. L. HENNEBERT 318

A revision of *Helotiopsis*. MARTHA A. SHERWOOD AND RICHARD P. KORF 319

[MYCOTAXON for October-December 1975 (3: 1-192)
was issued November 7, 1975]

ISSN 0093-4666 MYXNAE 3(2) 193-324 (1976)

Library of Congress Catalogue Card Number 74-7903

Published quarterly by MYCOTAXON, Ltd., P.O. Box 264, Ithaca, NY 14850
For subscription details, see back cover

MYCOTAXON

Vol. III, No. 2, pp. 193-208 January-March 1976

SIEMASZKOA AND BOTRYANDROMYCES, TWO SEGREGATES OF MISGOMYCES (LABOULBENIALES)

ISABELLE I. TAVARES

Department of Botany, University of California
Berkeley, California 94720

and

TOMASZ MAJEWSKI

Institute of Botany, Polish Academy of Sciences
al. Ujazdowskie 4, 00-478 Warszawa, Poland

SUMMARY

Laboulbenia heteroceratis and *Misgomyces heteroceri* are transferred to *Botryandromyces* gen. nov., characterized by clustered simple antheridia just above the spore septum and a perithecium with three cells in two adjacent rows of outer wall cells and four cells in the other two rows [*Botryandromyces heteroceratis* (Thaxt.) comb. nov. (holotype), *B. heteroceri* (Maire) comb. nov.]. *Misgomyces ptenidii*, *M. annae*, and *M. flexus* constitute the genus *Siemaszkoa* gen. nov., characterized by a many-celled, unbranched, uniseriate receptacle, a typically unbranched appendage, and a perithecium with three 3-celled rows of wall cells and one 4-celled row, in which the fourth cell protrudes apically beyond the terminal cells of the other rows [*Siemaszkoa flexa* (Majewski) comb. nov. (holotype), *S. ptenidii* (Scheloske) comb. nov., *S. annae* (Majewski) comb. nov.].

Although the perithecia of members of all genera of Laboulbeniales have four vertical rows of outer wall cells, there are different numbers of cells in these rows. The number of cells is a generic characteristic and is constant at maturity when the number is small. Among those genera with species having a large number of cells in each row of perithecial wall cells, there are a few, such as *Eusynaptomyces*, where alternating rows differ in number of cells because of a difference in cell lengths (see Scheloske, 1969). In some of the genera where each vertical row of wall cells consists of a small number of cells, there may be one more cell in one row than there is in another row. One such genus is *Misgomyces*, in which the type species *M. dyschirii* Thaxt. (on Carabidae and Staphylinidae) has four cells in each row of outer wall cells. This characteristic is shared only by *M. clivinae* Thaxt. (on Carabidae; Tavares, unpublished). In *M. heteroceri* Maire (on Heteroceridae) there are three cells in two adjacent rows and four cells in the other two rows. A similar cellular arrangement is found in *M. perpendicularis* Thaxt. and several other species ascribed to *Misgomyces* that occur on Carabidae (Tavares, unpublished). On the other hand, in *M. flexus* Majewski, *M. ptenidii* Scheloske, and *M. annae* Majewski (all on Ptiliidae) there are only three cells in three of the rows and four cells in the remaining row.

The most distinctive characteristic of *Misgomyces heteroceri* is the cluster of sessile or short-stalked phialides just above the original spore septum. This arrangement of antheridia also occurs in *Laboulbenia heteroceratis* Thaxter (1912), which was placed in *Laboulbenia* because of its 5-celled receptacle surmounted by a colorless cell resembling the insertion cell of *Laboulbenia* spp. However, our observations have shown that the perithecium of *L. heteroceratis*, like *M. heteroceri*, has two 3-celled outer wall cell rows and two 4-celled rows instead of all 4-celled rows as in *Laboulbenia* spp. In addition, the upper receptacle and appendages of *L. heteroceratis* are similar to those of *M. heteroceri*. Consequently, the two species must be considered congeneric.

Picard (1913) believed that *M. dyschirii* forms a compound antheridium; this opinion has been confirmed (Tavares, unpublished). Although the antheridium of *M. dyschirii* is rather simple in structure, such an antheridium makes it necessary to remove all other species from this genus as represented by *M. dyschirii* and establish other genera.

Two new genera are being proposed here to include not only the two species referred to above on Heteroceridae, but also three taxa occurring on Ptiliidae that have been placed in *Misgomyces*.

Botryandromyces gen. nov.

Paries perithecii exterior ex seriebus duabus cellularum ternarum altitudine inaequarum contiguis verticalibus et ex seriebus duabus cellularum quaternarum constans; receptaculum inferius ex cellulis duabus vel pluribus infra cellulam perithecii pedicellarem superpositis constans; receptaculum superius ex cellula una infima cellulas duas parallelas subtendente constans; antheridia sunt phialides supra cellulas receptaculi aggregatae, interdum etiam in ramis appendicularibus terminales vel laterales; perithecium cellula pedicellari secondaria cellulisque basalibus bene evolutis praeditum.

Perithecium with two adjacent vertical rows of wall cells consisting of three cells of unequal length and the other two rows consisting of four cells of unequal length; secondary stalk cell (*VII*) and basal cells (*m*, *n*, *n'*) of perithecium with well-defined walls; lower receptacle uniseriate, of two or more superposed cells; upper receptacle, above stalk cell (*VI*) of perithecium, normally 3-celled with the lowermost cell subtending two parallel cells; antheridia simple phialides (rarely with two cells discharging into a single neck) (Fig. 1b), arising from small cells just above the spore septum; antheridia also may be terminal or lateral on branches of appendage (Fig. 1c); lower tier of wall cells forming venter of perithecium shorter than cells of the second tier; fourth cell of 4-celled rows projecting slightly beyond terminal cells of 3-celled rows; spores normal, with two unequal cells; ascogenic cells 1--2; on Heteroceridae.

Etymology: *botrys*--cluster (of grapes); *andros*--male; *myces*--fungus.

Holotype: *Botryandromyces heteroceratis* (Thaxter) comb. nov. Basionym: *Laboulbenia heteroceratis* Thaxter, 1912, Proc. Amer. Acad. Arts Sci. 48: 207. On leg of *Heterocerus* sp., La Plata, Argentina. Also reported from Lawrence, Kansas, U.S.A. [unpublished hosts for specimens in Thaxter's collection are *Neoheterocerus pallidus* (Say) and *Lanternarius brunneus* (Melsh.), tribe Heterocerini according to the revision of Heteroceridae by Pacheco, 1964]. Other specimens from Argentina were found on *Erus ciliaticollis* (Steinh.) (Heterocerini) and *Heterocerus validus* Grouv. (Spegazzini, 1917) (latter species not included in Pacheco's revision, but placed in subgenus *Heterocerus* by Zaitzev, 1910). On various parts of body. Unpublished collection: *Heterocerus* sp., Salt Fork River, 2.5 miles northwest of Homer, Champaign County, Illinois, U.S.A., J. D. Unzicker, July 17, 1972; on elytra, upper part of head, legs, and tarsi.

One other species: *Botryandromyces heteroceri* (Maire) comb. nov. Basionym: *Misgomyces heteroceri* Maire, 1920, Bull. Soc. Hist. Nat. Afr. Nord 11: 159. On legs and elytra of *Heterocerus maritimus* Guér. (tribe Augyliini), mouth of Seybouse River, Cape Bône, Algeria (usually referred to subgenus *Litorimus*--see Balazuc, 1973, p. 253; however, *Litorimus* is not included among the tribes to which Pacheco elevated existing subgenera). Other collections: France--on *H. (Taenheterocerus) fusculus* Kiesenw., Trappes, Seine-et-Oise (Balazuc, 1973); West Germany--on *H. (T.) fusculus* and *H. (T.) fenestratus* (Thunb.), near Rettern/Forchheim and Kosbach/Erlangen (Scheloske, 1969); Poland--on *H. fusculus*, Smrock, Maków Mazowiecki County (Majewski, 1972). Unpublished collections from Poland: *H. fusculus*, *H. fenestratus*, marshy bank of Wkra River, Pomiechówek, Nowy Dwór Mazowiecki County, June--July, 1973; *H. (T.) intermedius* Kiesenw., marshy bank of small stream flowing into Bug River, Olendry, Siemiatycze County, June, 1970; *H. fenestratus*, sandy bank of Narew River, Sielc Stary, Maków Mazowiecki County, August, 1971; *H. fusculus*, marshy bank of small body of water near Wisła River, Buraków, Nowy Dwór Mazowiecki County, June, 1971 (collected by T. Majewski, determined by T. Plewka). Subgenus *Taenheterocerus* was included by Pacheco (1964) in tribe Augyliini.

Thalli of *Botryandromyces heteroceri* probably occur on all parts of the exoskeleton (Scheloske, 1969). Scheloske found two infected specimens among nine individuals of *H. fenestratus* and seven infected beetles among 28 of *H. fusculus*, but no thalli were seen on 17 individuals of *H. (Heterocerus) marginatus* (Fabr.) that he examined.

The North African specimens of *Botryandromyces heteroceri* were found on gregarious burrowing beetles in maritime mud. The hosts of the European collections often live together in moist, muddy or sandy, sun-heated places on the banks of rivers, ponds, and lakes. They excavate shallow, small burrows in which they usually live. The soil is commonly rich in organic material and has an abundant insect fauna; *Dyschirius* and *Bledius* are the most characteristic beetles of these habitats. Members of both genera bear *Misgomyces dyschirii*.

Infection of hosts is probably either by direct contact of insects or by contact with moist soil containing spores (see also Scheloske, 1969, p. 69). According to Dr. T. Plewka (personal communication), *Heterocerus* beetles are hatched in July and August in Poland; thus, it is probable that the beetles collected early in summer overwintered and were hatched the preceding year.

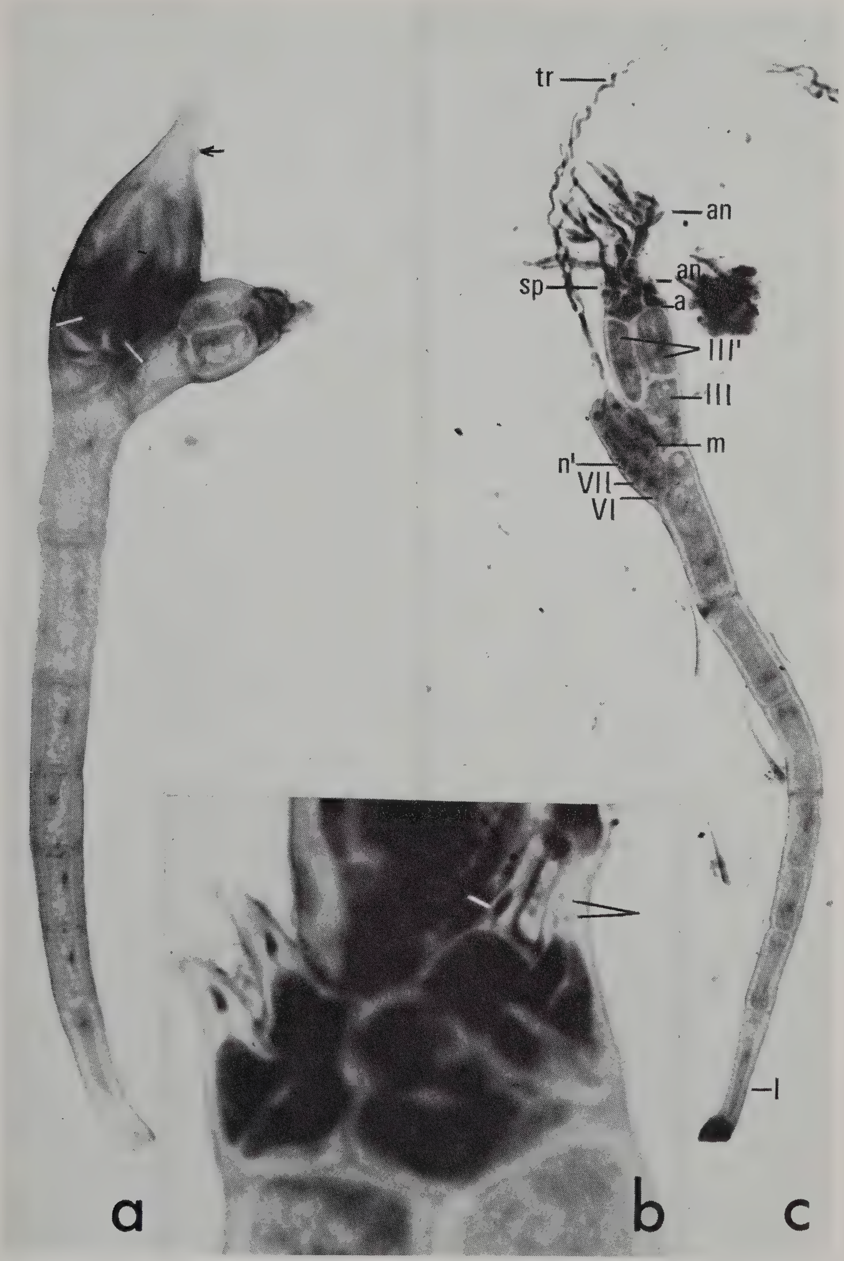
Scheloske believed that the Algerian specimens of *B. heteroceri* are taxonomically indistinguishable from those of West Germany (1969), although there is a deviation in size. The German specimens, which are from the prothorax and head, are mostly much larger (298-585μ in length, rather than 163-320μ); the lower receptacle has 4--9 cells, rather than 2--5, as in the Algerian thalli; the color appears to be paler; and there is scarcely any roughness of the outer surface of the receptacle. It is possible that the larger size of the European specimens, which was confirmed by Majewski (1972), results from growth in a more favorable location on the host. However, Maire's figures (1920) suggest that some of his measurements may be erroneous.

In the Polish collections of *B. heteroceri*, one specimen (from the prosternum) had an extremely long lower receptacle--518μ, with 13 cells; the smallest number of lower receptacle cells found was five. Although the longer receptacles tended to have a greater number of cells, there was some variation in cell length, which resulted in considerable difference in height among thalli with the same number of cells. For example, in two thalli from legs having seven lower cells, these cells were 40-68μ in length (total lower receptacle 354μ long) in one individual, while the other had cells 28-48μ in length (with the lower receptacle only 255μ long). As the thallus grows, the cells of the receptacle subdivide and horizontal septa are formed, at least in the earlier stages of development.

In *Botryandromyces*, the spore septum (*a*) is just above the two parallel *III'* cells of the upper receptacle (Figs. 1c, 2c). The perithecial initial (cell *d*) is cut off laterally by the *II* cell (in *B. heteroceri*, by the uppermost *II* cell). At this time, the inner cell *III'* is formed. At first, it is equal in length to cell *III* and separated from it by a vertical septum in *B. heteroceri* (Fig. 3d), whereas in *B. heteroceratis*, it is a short cell formed from the upper inner corner of cell *III* (Fig. 3c). Cell *III* subsequently divides and a horizontal septum separates the two daughter cells, the upper one becoming the outer *III'* cell (Fig. 3e). In *B. heteroceri*, cell *III* expands (Fig. 3f) until the vertical septum turns inward and becomes diagonal in its lower length; the upper receptacle eventually resembles that of *B. heteroceratis* in the arrangement of cells (Figs. 1c, 2c). Sometimes the internal *III'* cell divides in *B. heteroceri*, resulting in a 4-celled upper receptacle, according to Maire (1920).

In the young sporeling of *B. heteroceratis*, the upper septum of the basal appendage cell is thick and black (Fig. 3a). This cell divides, a horizontal septum is formed (Fig. 3b), and the lower daughter cell subsequently produces the cells of the antheridial zone (Fig. 2c). In both species, additional appendages arise from the antheridial zone and extend upward beside the initial primary appendage. In *B. heteroceri* these appendages bear antheridia differing in size and shape from the clustered antheridia below (Fig. 1c). In *B. heteroceratis*, antheridia borne laterally on

Fig. 1. *Botryandromyces heteroceri*. a. Mature thallus (from Smrock), showing trichogyne stump (arrow) and two groups of asci (white lines); rough outer wall of receptacle is visible. x 420. b. Antheridial cluster of thallus at 2-tier stage (trichogyne at right; Smrock specimen), showing two normal phialides at left and one at right (white line); antheridium at far right consists of two cells extending upward into one neck (v-line points to apices of spermatial upgrowths); acetocarmine stain. x 2500. c. Thallus at 2-tier stage (from Buraków), showing spiraled trichogyne (*tr*), spermatium (*sp*) in sessile antheridium at left, two superposed sessile antheridia (*an*) at right, spermatium-producing phialides (*an*) on appendages, and diagonal inner wall of cell *III*; acetocarmine stain. x 405.

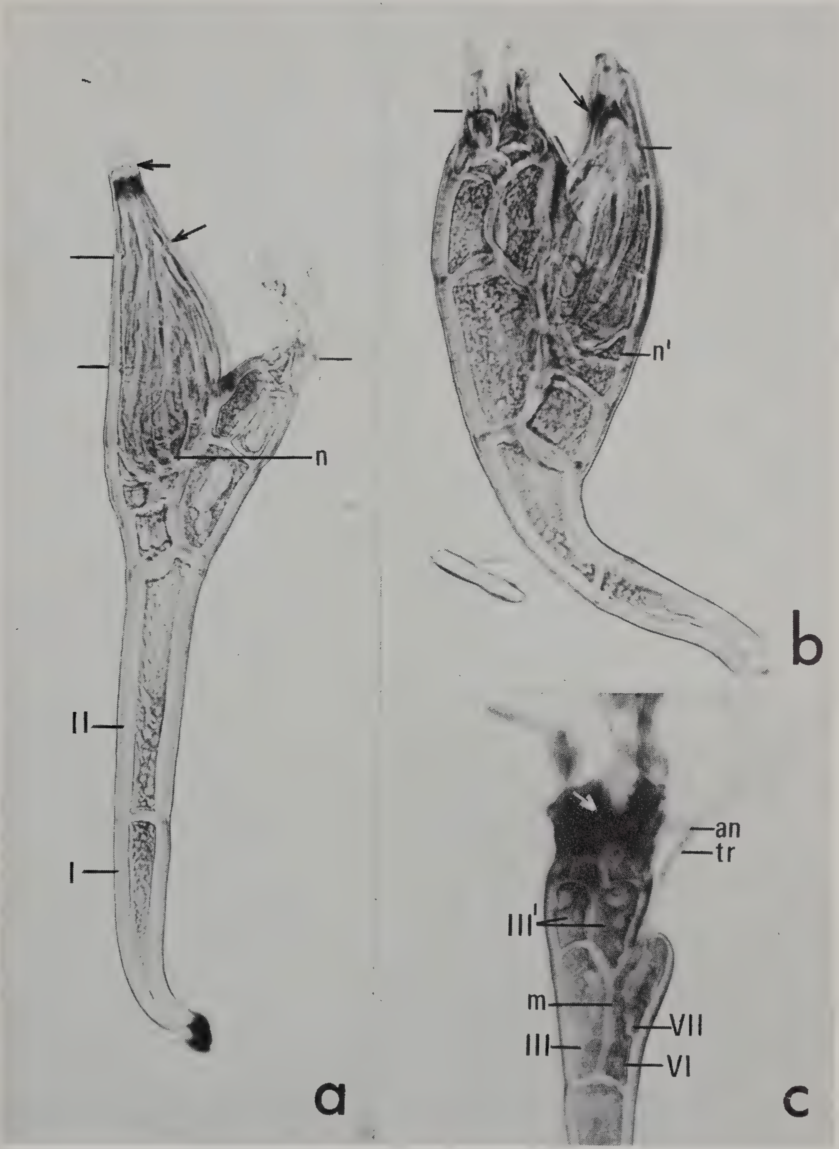

tr
an
an
sp
a
III'
III
m
n'
VII
VI
I
a
b
c

well developed primary appendages are closer in appearance to those grouped together in the antheridial zone, although they are narrow at the base. Subsequently formed appendages in *B. heteroceratis* apparently do not produce antheridia; they may become numerous in mature thalli, possibly proliferating from old, nonfunctional antheridia.

In addition to the more numerous cells in the lower receptacle (Maire reported in 1920 that they may sometimes be reduced to two), *Botryandromyces heteroceri* differs from *B. heteroceratis* in the following ways: (1) the upper receptacle cells are almost equal in length (Fig. 1a), whereas in *B. heteroceratis* the *III* cell is longer than the *III'* cells (Fig. 2c); (2) the thallus is devoid of a black septum on the primary appendage and lacks black color on the perithecium (see Figs. 2a, 2c); (3) cell *VI* is somewhat flattened, rather than roughly cubical or elongate; and (4) the *II* cells of the lower receptacle are typically shorter than cell *I*, whereas in *B. heteroceratis* the undivided cell *II* is usually longer than cell *I*.

As in *Botryandromyces heteroceri*, the 4-celled rows, with the trichogyne stump, are on the inner side of the perithecium in thalli of *B. heteroceratis* from Kansas and

Fig. 2. *Botryandromyces heteroceratis*. a. Holotype, from Argentina, showing twisting of outer perithecial wall cell rows (lower arrow to point where upper right wall cell row curves underneath), difference in length of rows (upper arrow to tip of 3-celled rows), and blackening of entire width of perithecium below apex; black septum of appendage barely visible (line at right); faint blackening present at junction of perithecium with upper receptacle; two wall septa visible at left (indicated by lines). x 370.
b. Slightly younger spore-producing thallus from Kansas (on *Neoheterocerus pallidus*; slide 9945), with broader cell *VI* and upper receptacle; black septum visible on appendage (line at left); blackening below apex of perithecium on inner side only (arrow); undivided third tier in shorter row visible at right (line at right). x 520.
c. Thallus (from Kansas, same host; slide 9944), at 1--2 tier stage, with black septum on appendage (white arrow); antheridial neck visible at right adjacent to trichogyne (out of focus). x 545.


n
II
I
a
n'
b
an
tr
III'
m
VII
III
VI
c

Illinois. Thus, cell *n*, which is in the normal position lying across one surface, produces both a 3-celled and a 4-celled row. The two long, blackened 4-celled rows in the Kansas specimens lie next to the appendage system (Fig. 2b). On the other hand, in the material from Argentina, the entire width of the perithecium is blackened near the apex and the short rows lie across one surface (Fig. 2a). This configuration results from a twisting of the wall cell rows, so that they are displaced one-fourth turn and the apex of the upper right-hand row lies on the lower surface of the thallus. The origin of the short rows is the same with relation to the *n*, *m*, and *n*' cells. A slight amount of twisting was detected in a thallus from Illinois.

Botryandromyces appears to be related to species of *Misgomyces s. lat.* occurring on Carabidae, particularly to those having unequal numbers of wall cells in different rows. The rare phialides in which two antheridial cells discharge through a single neck (Fig. 1b) bear a resemblance to the antheridial cells of *M. dyschirii*, which differ chiefly in their innate position. The tendency of the lower receptacle to undergo division has a parallel in *Laboulbenia partita* Thaxt. (see Maire, 1920, and Spegazzini, 1917, p. 555).

Siemaszkoa gen. nov.

Paries perithecii exterior ex seriebus tribus cellularum ternarum altitudine inaequarum contiguis verticalibus et ex serie una cellularum quattuor constans, cellula quarta apicaliter protrudente; receptaculum non ramosum, uniseriatum, ex cellulis tribus vel pluribus infra cellulam perithecii pedicellarem constans; cellula pedicellaris secondaria et cellulae basales misere evolutae; antheridia (si adsunt) sunt phialides breves basi latae, in parte inferiore appendicis primariae typice non ramosae sessiles.

Perithecium with three vertical rows of outer wall cells consisting of three cells of unequal length and one row of four cells of unequal length, the fourth cell of the latter row protruding apically (Fig. 4c), together with a short upgrowth of cell wall material rising above one of the opposite wall cell rows; receptacle uniseriate, unbranched, with three or more cells subtending the stalk cell of the perithecium; the secondary stalk cell and basal cells not evident at maturity because their cell walls do

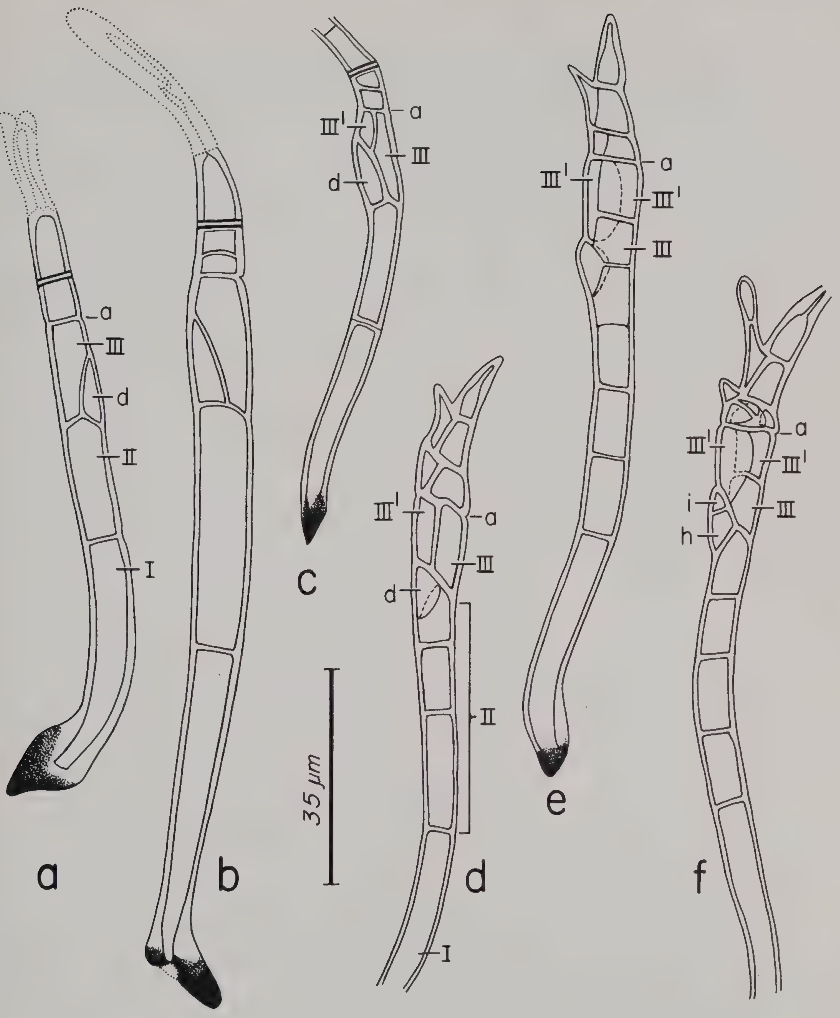


Fig. 3. a-c. *Botryandromyces heteroceratis* (from Illinois). a. Sporeling with undivided cell *III*; cell *II* has cut off perithecial initial cell (*d*) (2930a). b. Older thallus in which lower cell of appendage (above spore septum *a*) has divided (2930a). c. Thallus in which cell *III* has divided, forming cell *III*' (2904). d-f. *Botryandromyces heteroceri* (from Pomiechówek, 1329). d. Sporeling with cells *III* and *III*' of equal length; cell *II* has undergone division. e. Older thallus in which *III* has divided to form short *III*' cell above. f. Thallus in which cell *d* has divided to form cells *h* (perithecial primordium) and *i* (primordial cell of procarp); upper septum of cell *III* curves upward.

not thicken, although cells *VII* and *m* may be clearly visible in younger thalli; antheridia observed only in *S. flexa*, where they are short, sessile, with a broad base, and arise in a series from successive cells of the proximal part of the unbranched primary appendage (Fig. 4e); the appendage may branch somewhat in age, possibly by the proliferation of branchlets from nonfunctional antheridia. The antheridia of the other species may be evanescent; even in *S. flexa* they are difficult to observe in surface view. The spores are normal, with a shorter lower cell as viewed within the perithecium; the ascogenic cell is solitary.

Etymology: named after Janina and Wincenty Siemaszko, Polish investigators of Laboulbeniales.

Holotype: *Siemaszkoa flexa* (Majewski) comb. nov. Basionym: *Misgomyces flexus* Majewski, Acta Mycol. 9: 119. 1973. On *Ptenidium fuscicorne* Er., Kiełpin, Nowy Dwór Mazowiecki County, Poland.

Number of species: three, possibly four, because *Ecteinomyces pusillimus* Speg. may belong here (reported from unknown trichopterid [Ptiliidae] in ant nests, Argentina, by Spegazzini in 1917).

Siemaszkoa annae (Majewski) comb. nov. Basionym: *Misgomyces annae* Majewski, Acta Mycol. 9: 118. 1973. On *Ptilium myrmecophilum* (Allib.), Sadówka, Nowy Dwór Mazowiecki County, Poland.

Siemaszkoa ptenidii (Scheloske) comb. nov. Basionym: *Misgomyces ptenidii* Scheloske, Parasit. Schriftenr. Heft 19: 135. 1969. On *Ptenidium* sp. (*P. fuscicorne*?), near Schwand/Nürnberg and Dechsendorf/Erlangen, West Germany. Also reported (Majewski, 1973b) on *Ptenidium fuscicorne* Er., Kurzeszyn Nowy, Rawa Mazowiecka County, Poland. Another collection from this host species (Warszawa-Morysinek, 1 May 1972, B. Burakowski) differs in having a shorter, broader perithecium (120μ x 25μ) and smaller spores (ca. 23μ x 1.25μ inside perithecium), but it has a similar cell *VI* and receptacle cells (Fig. 4a). A large form of *S. flexa* occurred with it, in which the perithecium is 58μ long x 37μ wide, with the receptacle 102μ below cell *VI* (Fig. 4e).

Scheloske (1969) reported a 6.8% infection of 161 beetles of *Ptenidium* examined. He found his specimens in *Alnus* woods, in moist, rich soil, and in piles of plant debris on pond margins. Polish specimens of *S. ptenidii* and *S. flexa* were also found in debris under *Alnus*, whereas *S. annae* was found in an anthill.

The species of *Siemaszkoa* differ in the shape of cell *VI*, the number and shape of cells in the receptacle, and the shape and orientation of the perithecium at maturity, as well as the position of the 4-celled row of outer wall cells. Although the perithecium remains parallel to the persistently erect appendage in *S. ptenidii* and *S. annae* (Fig. 4a, 4b), in *S. flexa* it is bent sharply downward at maturity by curvature of the receptacle just below cell *VI* (Fig. 4d); at the same time, the appendage turns outward. Although the perithecium of *Ecteinomyces pusillimus* does not bend downward, the appendage grows outward as the thallus matures. Although Spegazzini (1917) stated that the basal cells of the perithecium are visible, his drawing shows only the faint outline of one cell above cell *VI*. The presence of sessile conical antheridia on the lower cells of the appendage and the small size of the thallus suggest that this species belongs in *Siemaszkoa*, although it is possible that it is related more closely to *Ecteinomyces trichopterophilus*.

The trichogyne in *Siemaszkoa flexa* is at the level of the lower part of the upper wall cell tier at the 2-tier stage; this lower portion is later cut off by a septum. Thus, at the 3-tier stage, the second tier is very short and indicates the position of the trichogyne stump (Fig. 4e), which is located on the outside of the perithecium in *S. ptenidii* and on the inside in the other species. The trichogyne stump is on the 4-celled wall row, which is slightly longer; Scheloske's drawing (1969) shows a longer outer row in *S. ptenidii*. Evidently in this species there is some twisting of the perithecium, as the trichogyne usually faces the appendage in the Laboulbeniales.

The following is a key to the species:

Perithecium swollen, ca. obpyriform, bent backward parallel to receptacle at maturity; cell *VI* short, flat, broad; receptacle many-celled. *S. flexa*

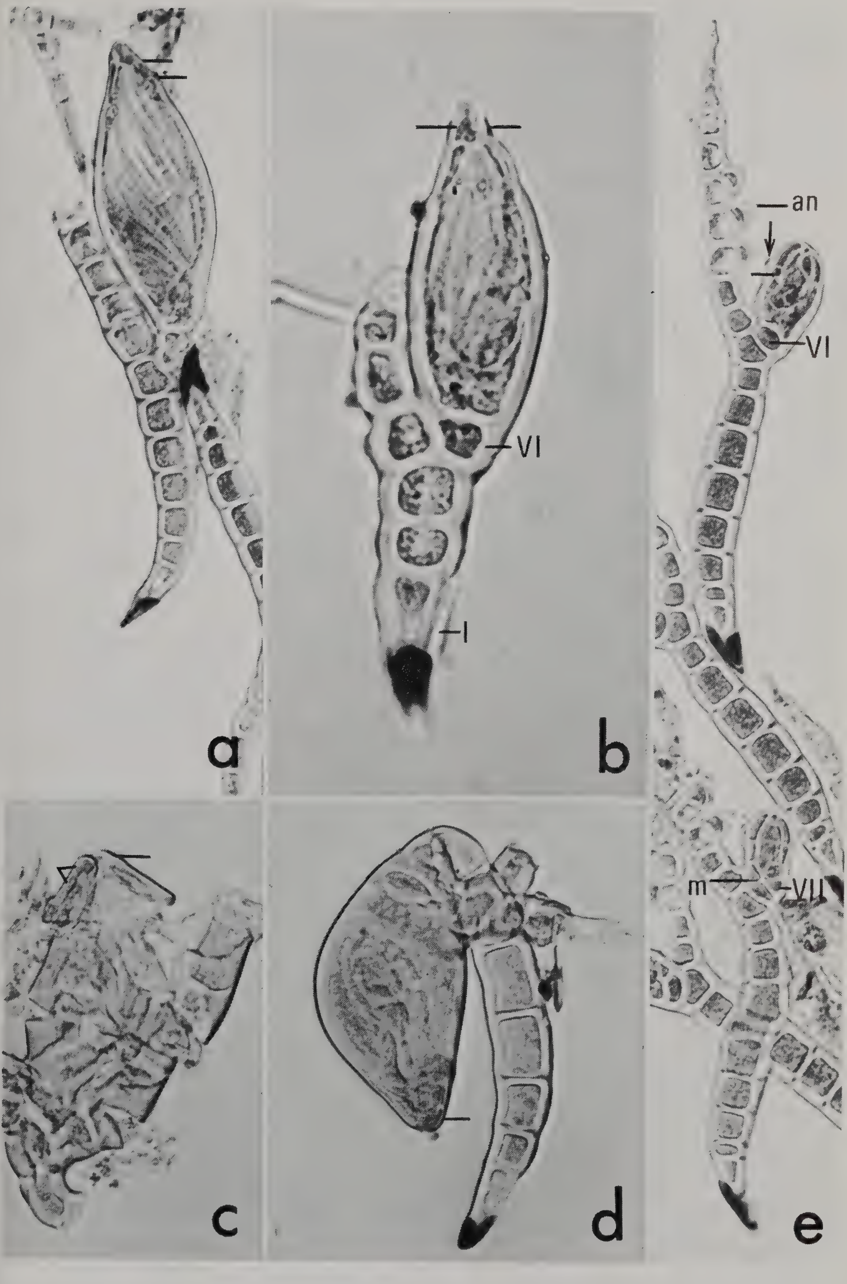
Perithecium ca. obclavate, borne erect at maturity.
Receptacle few-celled (ca. 3); cell *VI* cubical; extra wall cell in row on inner side of perithecium. *S. annae*
Receptacle many-celled; cell *VI* elongate; extra wall cell in row on outer side of perithecium. *S. ptenidii*

Siemaszkoa is closely related to *Euphoriomyces*, *Carpophoromyces*, *Meionomyces*, and *Phaulomyces*, which have similar perithecia (I. Tavares, unpublished). The antheridia of *S. flexa* are similar to those of *Carpophoromyces*.

ACKNOWLEDGMENTS

The authors wish to thank Dr. B. Burakowski (Institute of Zoology, Polish Academy of Sciences) for the mixed collection of *Siemaszkoa*, Dr. T. Plewka (Institute of Ecology, Polish Academy of Sciences) for determination of Heteroceridae, and Dr. Reed Rollins and others of the Harvard University herbaria for making Thaxter's slides of *Laboulbenia heteroceratis* available for study. They are also indebted to the late Mr. Sam Ehrlich, Mr. James Hendel, and Mr. Gene Groppetti, Scientific Photographic Laboratory, University of California, Berkeley, for the photographs, and to Miss Charlotte Mentges for assistance with the draw-

Fig. 4. *Siemaszkoa*. a. *S. ptenidii* (Burakowski collection), showing extra cell on outer side of perithecial apex (line to its base; lower line indicates trichogyne stump); associated young thalli are *S. flexa*. x 640. b. *S. annae*, mature thallus, type collection, showing extra apical cell in inside row (line at left) and flap of wall material (line at right) on outer side of perithecial apex. x 1440. c-e. *S. flexa*. c. Apex of mature perithecium (from type collection), flattened, showing two outer wall cells in row at left (v-line) and upgrowth of wall material at right (line). x 600. d. Holotype, mature thallus, showing curve of thallus at maturity and extra apical cell in inside row (line); lateral branch base is visible on appendage. x 600. e. Thallus, 3-tier stage (Burakowski collection; upper specimen), showing sessile antheridia, trichogyne stump (arrow), and short second tier; lower thallus is in 2-tier stage. x 640.


an
VI
VI
I
m
VII
a
b
c
d
e

ings. The Latin diagnoses by Dr. W. J. Dress, Bailey Hortorium, Cornell University, are gratefully acknowledged. Dr. R. K. Benjamin, Rancho Santa Ana Botanic Garden, very kindly provided specimens for *L. heteroceratis* from Illinois for examination, as well as helpful suggestions for the manuscript.

LITERATURE CITED

Balazuc, J. 1973. Laboulbeniales de France. Bull. Mens. Soc. Linn. Lyon 42: 244-256.

Maire, R. 1920. Troisième contribution à l'étude des Laboulbéniales de l'Afrique du Nord. Bull. Soc. Hist. Nat. Afr. Nord 11: 123-138, 143-170.

Majewski, T. 1972. Rare and new Laboulbeniales from Poland. Acta Mycol. 7: 269-277.

__________. 1973a. Rare and new Laboulbeniales from Poland. III. Acta Mycol. 9: 111-124.

__________. 1973b. Rare and new Laboulbeniales from Poland. IV. Acta Mycol. 9: 229-238.

Pacheco M., F. 1964. Sistematica, Filogenia y Distribución de los Heteroceridos de America (Coleoptera: Heteroceridae). Monogr. Col. Post.-grad. no. 1. Pp. I-XII, 1-155. Figs. 1-501. Escuela Nacional de Agricultura, Colegio de Post-graduados, Chapingo, México.

Picard, F. 1913. Contribution à l'étude des Laboulbéniacées d'Europe et du nord de l'Afrique. Bull. Soc. Mycol. France 29: 503-571. Pls. XXIX-XXXII.

Scheloske, H.-W. 1969. Beiträge zur Biologie, Ökologie und Systematik der Laboulbeniales (Ascomycetes) unter besonderer Berücksichtigung des Parasit-Wirt-Verhältnisses. Parasitol. Schriftenr. Heft 19: 1-176.

Spegazzini, C. 1917. Revisión de las Laboulbeniales argentinas. An. Mus. Nac. Hist. Nat. Buenos Aires 29: 445-688.

Thaxter, R. 1912. New or critical Laboulbeniales from the Argentine. Proc. Amer. Acad. Arts Sci. 48: 153-223.

__________. 1931. Contribution towards a monograph of the Laboulbeniaceae. V. Mem. Amer. Acad. Arts Sci. 16: 1-435. Pls. I-LX.

Zaitzev, Ph. 1910. Dryopidae, Cyathoceridae, Georyssidae, Heteroceridae. Coleopterorum Catalogus. Part 10: 1-68.

MYCOTAXON

Vol. III, No. 2, pp. 209-232 January-March 1976

TAXONOMY, MORPHOLOGY AND ONTOGENY OF GELATINODISCUS FLAVIDUS[1]

STEVEN E. CARPENTER

Plant Pathology Herbarium, Cornell University
Ithaca, New York 14853

ABSTRACT

The gross morphology of the ascocarp of a subalpine Discomycete, *Gelatinodiscus flavidus*, is described in detail. Development of apothecia from artificially inoculated twigs and needles of the host, *Chamaecyparis nootkatensis* (Alaskan yellow cedar), is described. These arise from hyphae which leave infested needles through exit tubes (new term) in the host epidermal cell wall and exit pegs (new term) in the host cuticle. Ascospore germination results in a thick-walled, pigmented, lunate structure referred to here as a 'secondary spore.' A microconidial state possibly referable to the genus *Myrothecium* was discovered; microconidia were found attached to trichogynes, and it is suggested that they may act as spermatia. Discovery of the inoperculate nature of the ascus in *G. flavidus* and the necessity to transfer it from the Pezizales is discussed. A new family, the Gelatinodiscaceae (Helotiales), is erected for the monotypic genus *Gelatinodiscus*. The Gelatinodiscaceae represents a family perhaps intermediate between the Cyttariaceae (Cyttariales) and the Leotiaceae (Helotiales).

---

[1] Based on a thesis presented to the Graduate School of Cornell University in partial completion of the requirements for the degree of Master of Science.

INTRODUCTION 210
MATERIALS AND METHODS 211
  Source of cultures and isolation procedures 211
  Culture media 211
  Ascospore germination studies 212
  Histological procedures 213
HABITAT 213
VEGETATIVE GROWTH IN CULTURE 214
DEVELOPMENT OF THE APOTHECIUM 215
ANATOMY OF THE ASCOCARP 219
THE ASCUS 222
THE ASCOSPORE 223
  Development 223
  Germination 225
SPORODOCHIA AND MICROCONIDIA 228
DISCUSSION 229
FORMAL TAXONOMY 231
ACKNOWLEDGEMENTS 231
LITERATURE CITED 232

INTRODUCTION

The genus *Gelatinodiscus* and its single species, *G. flavidus*, was first described by Kanouse and Smith (1940) and placed in the order Pezizales, family Pezizaceae, based on "the operculate asci, large *Peziza*-like spores and the friable consistency of the dry apothecia." It was characterized by them as having asci that blue at the apices in Melzer's reagent, circinate, anastomosing paraphyses, and eight, hyaline, biguttulate ascospores. Its host is *Chamaecyparis nootkatensis* (D. Don) Spach (Alaskan yellow cedar). It is only found under snow or in runoff water from melting snowbanks.

Since that time, few workers have dealt with the structure or taxonomy of this organism. Eckblad (1968) briefly discussed the genus in a list of excluded genera; Korf (1972, 1973b) briefly discussed the genus in his Discomycete keys, finally deciding (Korf, 1973a) that *Gelatinodiscus* does not belong in the Pezizaceae, but making no suggestions as to its proper taxonomic position. Ecological mention of this fungus was made by Cooke (1955) in a footnote. Seaver (1942, 1951) did not cite the genus in his extensive treatment of North American Discomycetes.

In July, 1972 in the Mt. Jefferson Wilderness Area of Oregon, the author had the opportunity to collect this relatively unusual Discomycete. Whereas Kanouse and Smith (1940) had erroneously reported the ascus to be operculate, my fresh collections, when mounted in Melzer's reagent, showed a very distinctive apical pore in the ascus. Since one of the major taxonomic criteria used in Discomycete taxonomy is the operculate or inoperculate nature of the asci, the placement of this genus in taxonomic treatments based extensively on literature surveys has been erroneous.

The discovery of the inoperculate nature of the ascus, and the further discovery of simultaneous maturation of the asci of *Gelatinodiscus* by Dr. R. P. Korf (*pers. comm.*) and myself led me to undertake anatomical and developmental studies.

MATERIALS AND METHODS

Source of cultures and isolation procedures

Ascocarps of *Gelatinodiscus* were collected near Breitenbush Lake, Oregon, in late July, 1972. Fresh apothecia were placed in glass vials and plastic bags in the field, and in turn placed in an ice-chest. Within 4 hr of collection, fresh ascocarps were affixed to Petri dish lids with petroleum jelly, such that the hymenium faced downwards when the lid was placed on the dish bottom. Ascospores were ejected from the apothecia onto water agar in the dish; the lid was rotated slightly every few minutes to disperse the ascospores over the agar surface.

Upon germination, spores were harvested *en masse* from the agar surface and transferred to agar slants. These cultures were maintained in darkness at 6 C.

Culture media

All media were autoclaved for 20 min at 1.1×10^5 N/m^2 and 121 C unless otherwise stated.

Stock cultures were maintained on slants of "Difco" potato dextrose agar (PDA) in test tubes at 3 C and remained viable for over a year. For rapid production of vegetative mycelium, a yeast-glucose liquid medium (YG) consisting of 0.5% "Difco" yeast-extract and 2.0% glucose in tap water was employed. A 2% "Difco" water agar (WA) was also used in some experiments.

For detection of fermentative or oxidative metabolism, "Difco" bacto-OF basal medium (OF), after Hugh and Leifson

(1953) was used. The medium was supplemented with glucose to a final concentration of 1%. OF medium includes Bromthymol-blue as an indicator which turns from dark greenish-blue to bright yellow in the presence of fermentative metabolism. Mycelium from YG cultures was placed deep in the agar near the bottom of tubes containing 10 ml of the indicator medium. This preparation was covered with sterile, molten petrolatum to a depth of approximately 1 cm and incubated at 24 C. Controls with no inoculum and controls without petrolatum were also prepared.

Sexual reproductive processes were studied on an undefined or "natural" medium (NM). Forest litter and fallen cones and twigs of *C. nootkatensis* were collected from the summit of Iron Mountain in the Cascade Mountains of Oregon at 1700 m; ascocarps of *Gelatinodiscus* were found in the vicinity of this collection. The substrata were air-dried and stored in paper bags for 6 months or more before use.

When needed, the forest litter (consisting primarily of leaves of *Abies lasiocarpa* and *Vaccinium* spp.) was placed in a thin layer at the bottom of a 5 cm Petri dish lid and several *Chamaecyparis* twigs and cones of various ages were placed on top of this layer and wetted with tap water. This container was in turn placed in the bottom of a 9 cm Petri dish and covered with the lid of the larger dish. After autoclaving, inoculum from PDA slants was placed on top of the *C. nootkatensis* twigs. Following inoculation, plates were placed in a walk-in chemical storage room (used primarily for the storage of organic solvents) maintained at 4 C, with fluorescent lamp approximately 40 cm above the lid of the dishes providing approximately 690 lux for 16 hr per day. As cultures began to dry up over extended periods of time, sterile tap water was added.

Ascospore germination studies

Mature apothecia from NM cultures were affixed to Petri dish lids and allowed to eject ascospores onto WA as described above.

Sterile cellophane strips and cotton strands were placed separately on PDA plates; twigs of *C. nootkatensis* were placed on 2% WA. Agar blocks bearing ascospores were placed with the spore-bearing face down directly on the cotton strands and cellophane strips, or blocks were placed adjacent to twigs of *Chamaecyparis* with the spore-bearing face up. All treatments were incubated as described above for NM cultures.

Histological procedures

Squash mounts were prepared in cotton blue-lactophenol, Phloxine-B dye or Melzer's reagent. In addition, a 1% solution of Congo red in 2% aqueous KOH was used in the study of ascus wall structure. These stains are widely used by Discomycete workers and are described by Dennis (1968) and Korf (1973b).

To study initial development of fungal structures on the host, it was usually necessary to employ paraffin sections. Specimens were fixed in Carnoy's fixative with the formulation of 6 parts absolute alcohol, 3 parts chloroform and 1 part acetic acid. In a few instances, specimens were fixed in formalin-acetic-acid (FAA) after Jensen (1962).

To avoid loss of fungal material on *Chamaecyparis* twigs, the specimens were covered with molten WA after a 1 hr fixation, allowed to harden and replaced a fixative. Specimens were then placed in a slight vacuum for a minimum of 8 hr, dehydrated in a tertiary butyl alcohol series and embedded in 53-55 C "Bioloid" paraffin after Jensen (1962). Sections 10 µm thick were cut on a rotary microtome and affixed to microscope slides using Haupt's adhesive with 4% formalin.

Slides were stained in safranin-fast green or Heidenhain's iron haematoxylin with a counterstain in fast green after Jensen (1962). After staining, slides were mounted in Canada balsam and heated at 65 C for two days.

HABITAT

Gelatinodiscus flavidus is host specific for fallen needles, cones and small branches of Alaskan yellow cedar, *Chamaecyparis nootkatensis*. From collections made by the author and from a survey of the literature, the range of *G. flavidus* extends from British Columbia (Eckblad, 1968) south to central Oregon, based upon my own collections. Frenkel (1974) reported a disjunct population of *C. nootkatensis* in the Aldrich Mountains in eastern Oregon; at my request, *Gelatinodiscus* was sought and found there on the host by Frenkel, who kindly forwarded the material to me. The host range is discussed further by Hepting (1971). The climate for the host is described as moderate to cool, with cool, humid summers and winters that are not severe. Temperatures may occassionally drop to -28 C. Mean annual precipitation ranges from 50 to 250 cm.

Gelatinodiscus can be found fruiting beneath the snow, but more often at the seepage edge of melting snowbanks. If found under the snow, the apothecia are usually found on branches not directly in contact with the snow, but instead entangled beneath other branches. In such cases, the mass of branches is saturated with moisture.

VEGETATIVE GROWTH IN CULTURE

The vegatative hyphae of *G. flavidus* develop very slowly on PDA at both 4 C and 24 C. Most growth occurs beneath the agar surface in a spherical, dull-white colony, perhaps indicating a preference for an environment with a low oxygen concentration. As colonies age, they become dark brown. After two months of growth on PDA at 4 C, the mycelium, which is normally composed of cells 25-30 X 4-5 µm, rounds up into large, globose vesicles, 10-15 µm in diameter. The mass of vesicles becomes surrounded by a dark brown fungal exudate, forming a compact tissue which superficially resembles a stroma. However, no definite tissue layers are differentiated within the mass.

YG liquid cultures grow relatively fast at 24 C, a dense growth of white mycelium appearing around the contrastingly dark brown inoculum within 5 days. Growth in YG cultures is quite slow at 4 C. Colonies in YG always remain at the bottom of the culture tube. Cultures in 1.5% YG agar emit a characteristic "yeasty" odor after approximately one week at 24 C.

Inoculations into the OF medium indicated that *Gelatinodiscus* is capable of anaerobic, fermentative growth. The color of the medium changed from dark greenish-blue to bright, clear yellow within 36 hr after inoculation. Uninoculated control tubes remained dark greenish-blue in color. Control tubes without petrolatum seals turned the medium light greenish-yellow within one week after inoculation.

Mycelium in NM culture dishes always remained at the bottom of the dish, completely covering the substrata within 3 to 4 months. In general, aerial hyphae were bright yellow in color, closely corresponding to the color of mature apothecia. When such cultures were allowed to air-dry before the onset of apothecial production, the mycelium and substrata adhered together in a compact disc. When such a disc, after several months of storage, was rehydrated with sterile tap water and replaced in the NM growth chamber, apothecia were produced within two months.

When inoculum from one-year-old PDA cultures was placed in moist chambers, the top of the inoculum block soon became covered with bright yellow hyphae in small clumps, resembling the globose primordia formed in NM cultures, as described in a later section. However, no mature archicarps could be discerned in such structures.

DEVELOPMENT OF THE APOTHECIUM

The apothecium proper is completely epiphytic on the needles and twigs of *C. nootkatensis*, but is connected to hyphae in the epidermal cells of needles. Primordia, which usually give rise to two apothecia, are visible as discrete brown spots on twigs with the naked eye. As development proceeds, the primordia are topped with one or two bright yellow, globose structures, which consist of the archicarp and ensheathing hyphae.

The primordium (Fig. 1A,C) consists of a basal layer of globose cells, dark brown fungal exudate, archicarps and ensheathing hyphae. The basal layer of hyphae, which are 5-6 μm wide, is 3-6 cells thick, tapering to 1-2 cells at the edges. Hyphae in the basal regions of the primordium are surrounded by a large amount of dark brown exudate.

Hyphae in the palisade and epidermal layers are 7-10 (-15) μm across and uninucleate. Epidermal cells of the host are each packed with 3 to 6 globose fungal cells, which in turn arise from profusely branching, broad hyphae in the palisade layer of the needle. About 6 epidermal cells beneath the primordium (in sectional view) are filled with hyphae; these hyphae are connected between epidermal cells.

Hyphae in the portion of the epidermal cell adjacent to the cuticle produce a smooth-walled cylindrical tube, here termed an *exit tube*, through the epidermal cell wall, but not into the cuticle (Fig. 1D,E). The exit tube is 1.0 μm in width; a brown exudate can be seen surrounding it in the host cell wall. A thin, tapering hypha, here termed an *exit peg*, is formed from the exit tube, is rough-walled, yellowish-brown, 1.0 μm wide at the base and tapers to a fine point at the apex, leading from the exit tube apex through the cuticle and connecting with a globose cell at the base of the primordium. The exit peg stains in fast green.

SEE ERRATA

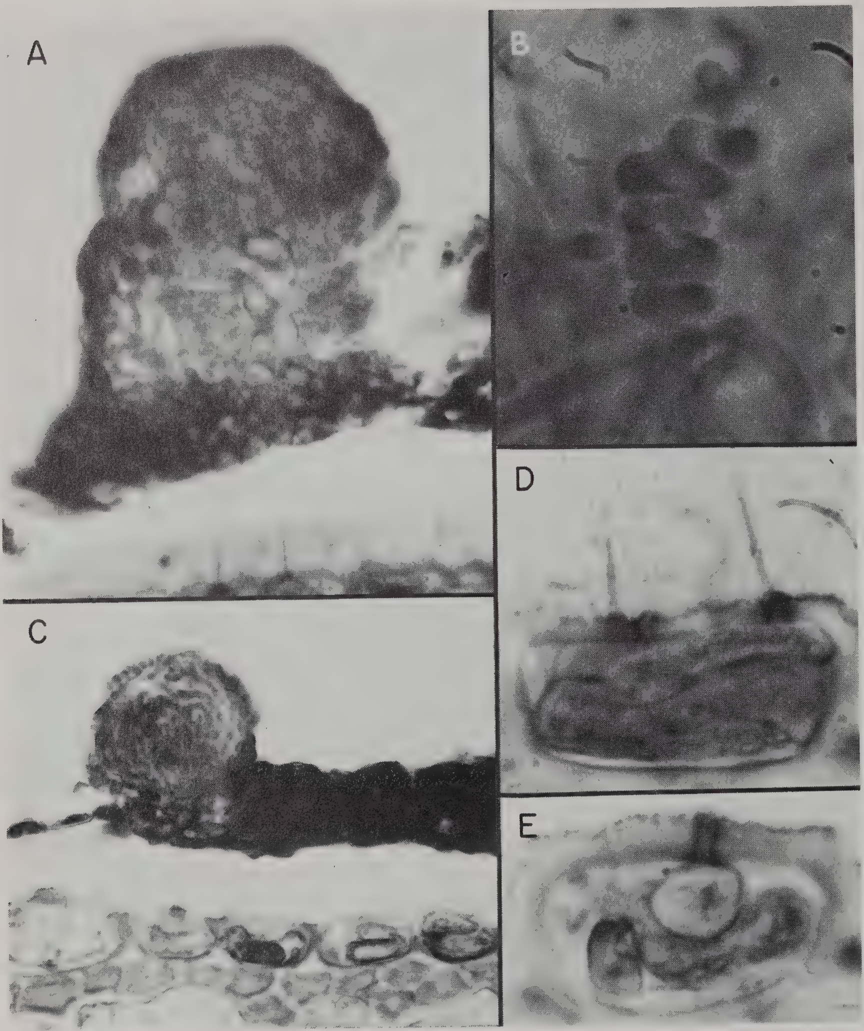


FIG. 1. Photomicrographs of *Gelatinodiscus flavidus* from NM cultures, A, CE, 10 μm paraffin sections in safranin-fast green, bright-field microscopy; B, squash mount in cotton blue-lactophenol. A. Remains of archicarp present in developing apothecium on needle, with exit pegs visible in the host cuticle, × 620. B. Detail of archicarp teased out of a developing primordium, × 1500. C. Primordium subtended by an exit peg produced by hypha in a host epidermal cell, × 620. D. Detail of host epidermal cell filled with hyphae which have produced exit tubes and exit pegs, × 1500. E. Detail of exit tube in host epidermal cell, × 1500.

In general, only one exit peg per hypha in the epidermal cell is produced, although a hypha may produce two such pegs in rare instances. As many as eight exit pegs have been observed connecting a primordium with hyphae in the epidermal cells of the host.

In the central region of the primordium are found one or more archicarps and ensheathing hyphae. Usually two archicarps are formed, each apparently capable of giving rise to a complete apothecium. The archicarp is bounded at the top by the trichogyne and at the base by a foot cell. Unfertilized, whole archicarps are difficult to demonstrate. In one observed case, the archicarp (Fig. 2) consisted of 14 uninucleate cells, 4-5 X 10 μm, arranged in five to eight tight coils. The trichogyne connected to this archicarp consisted of eight cells, the first six 2 X 15 μm, the seventh 2 X 30 μm and the eighth or terminal cell 2 X 75 μm. The terminal cell was devoid of cytoplasm. The foot cell is 2-2.5 X 10 μm. The ensheathing hyphae surrounding the archicarp are 1-1.5 μm broad, and with the archicarp form a bright yellow globose structure, 40-60 μm across, just visible to the naked eye.

After fertilization the archicarp foot cell is carried upward with the other cells of the developing stipe until the archicarp is 50-75 μm from the base of the stipe. At this point, the outer excipular layers have differentiated from cells at the sides of the primordium into a characteristic textura prismatica, surrounded by a layer of protruding "hairs." Under the dissecting microscope, the apex of the stipe takes on a watery or filmy appearance, in sharp contrast to the dull appearance of the sides of the stipe.

After the initial upward expansion of the stipe, thin-walled ascogenous hyphae can be seen within the tissues of the stipe. Cells comprising these hyphae are 4-6 X 12-15 μm, often collapsing in paraffin sections and appearing to be almost devoid of cytoplasm. Nuclei are difficult to observe in these cells. Ascogenous hyphae stain much lighter in iron haematoxylin-fast green mounts than the surrounding hyphae. The ascogenous hyphae branch extensively within the medullary excipulum as upward expansion of the stipe continues.

When the stipe has elongated to a height of 4 to 5 mm, the apex begins to expand laterally, the watery apex expanding with the outer tissues of the stipe, the ascogenous hyphae begin profuse branching, contributing to the developing hymenium, paraphyses are formed from hyphae in the medullary excipulum, and the margin is differentiated.

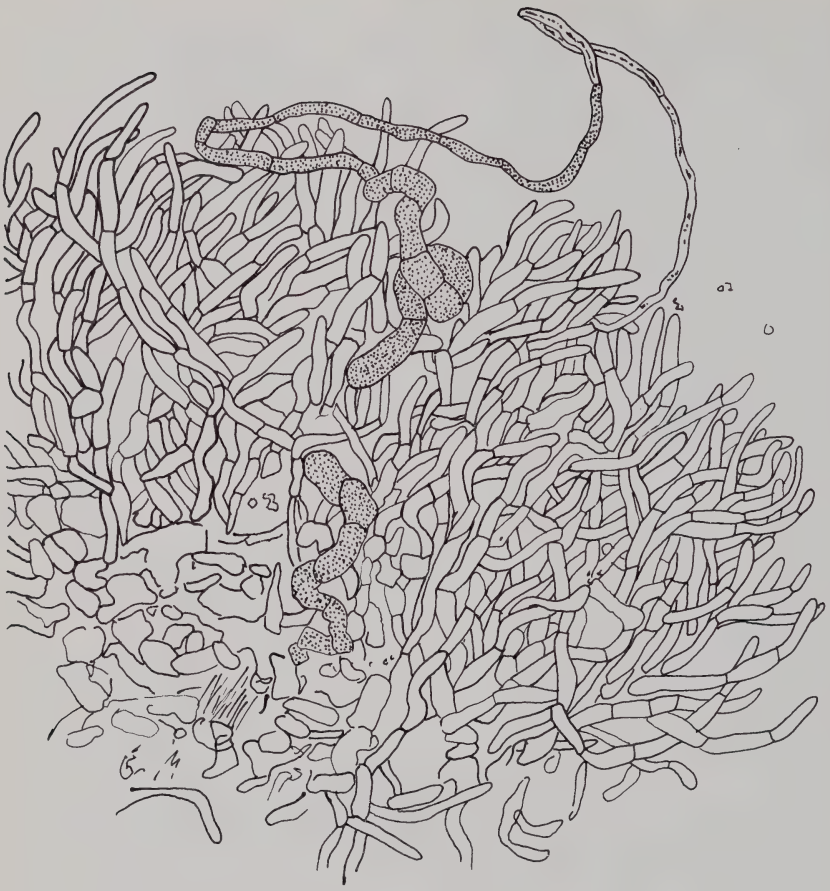


FIG. 2. Camera lucida drawing of a primordium containing an archicarp and trichogyne, × 850.

Laterally protruding "hairs" are present on the outer surface of the apothecium. The cells of the archicarp are now only visible as thick-walled hyphae, devoid of cytoplasm and covered with a brown incrustation, near the base of the stipe. Once the margin and hymenium differentiate, a period of 7 to 9 days elapses in culture before formation of the fully expanded and repand hymenium.

During development, young apothecia are positively phototropic. If culture dishes are turned so that the apothecia are facing away from the light source, the stipe bends towards the light within 24 hr. Once lateral expansion of the apex of the apothecium commences, the phototropic response diminishes or disappears.

It appears from culture experiments that maintenance of proper substrate moisture and humidity is important in the production and development of apothecia. More apothecia were found on twigs perched above the water level in culture dishes than twigs that were partially submerged. In addition, submerged hyphae remain off-white in color, and as the water level recedes, hyphae exposed to the air become bright yellow.

Apothecia only developed on *C. nootkatensis* materials in the dishes, and not on the other litter. In general, younger twigs produced the bulk of apothecia and primordia, while woody twigs and cones produced few apothecia. Apothecia failed to develop on any of the agar media used in various experimental regimes.

As Kanouse and Smith (1940) have previously described, the apothecia of *G. flavidus* reach a maximum diameter of 5 mm and a height of 5-8 mm. The color of the apothecium is bright yellow and not at all greenish or greenish-brown as Korf (1972, 1973b) has indicated. His comments (R. P. Korf, *pers. comm.*) were based on examination of fresh material of a Japanese Discomycete not yet fully studied (Korf, 1966; Sagara, 1974), but which, based upon my examination, is not a species of *Gelatinodiscus*.

ANATOMY OF THE ASCOCARP

At the time of the original diagnosis of *G. flavidus*, microanatomical characteristics of apothecia were not of the taxonomic importance that they are presently. Therefore I provide an emended description here. Terms used are based on those presented by Korf (1973b).

ECTAL EXCIPULUM: The outermost layer of the ectal excipulum is composed of uninucleate, elongate, septate hyphae, 5-7 µm in width, interwoven in a textura porrecta 20 µm thick. At the base of the stipe these hyphae originate from the cells composing the inner layer of the ectal excipulum. Most of the hyphae lie parallel to the long axis of the stipe, but there are many tapering, septate branches (or "hairs") lying at right angles to the stipe (Fig. 3C). These branches form the hairy or cobwebby appearance of very young apothecia.

The inner layer of the ectal excipulum is 80-100 µm thick, and is composed of angular to rectangular cells, forming a textura prismatica (Fig. 3A,C). These cells are thin-walled, 20-45 X 10 µm and 2- to 4-nucleate. At the base of the stipe, these cells are covered with dark brown exudate. As the apothecium expands upward and outward, this exudate becomes ruptured. The rectangular cells near the base of the stipe narrow into the thin-walled cells forming the outermost layer of the ectal excipulum, and protrude through the brown exudate.

MEDULLARY EXCIPULUM: The medullary excipulum is composed of long-celled hyphae, the cells 3-8 X 30-60 µm, and 2- to 4-nucleate, forming a textura intricata. Near the base of the stipe, the hyphae are closely packed, becoming very loosely arranged as the zone of paraphysis differentiation is neared (Fig. 3A,B). Large interhyphal spaces are present in the upper portion of the medullary excipulum.

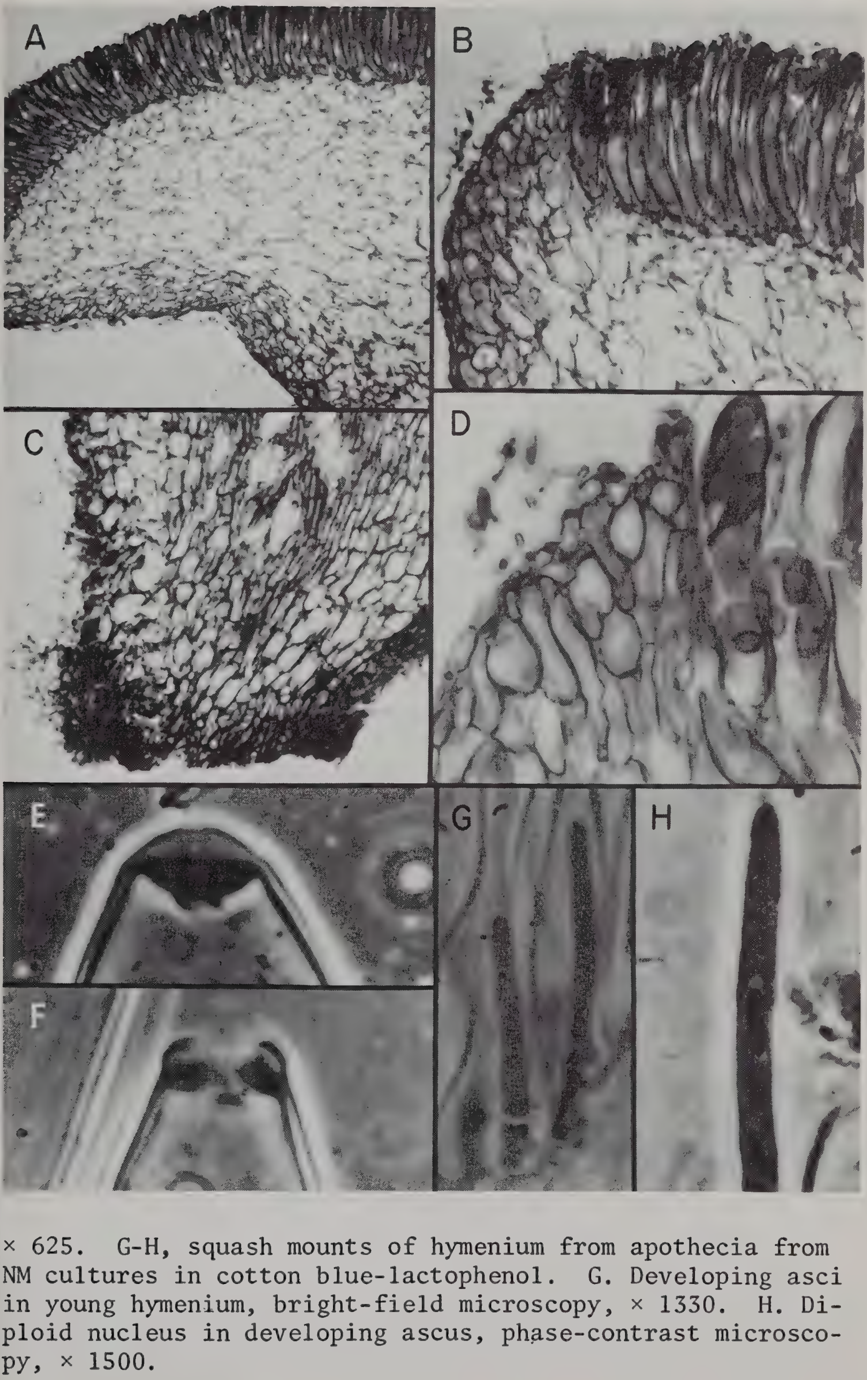
MARGIN: The margin is composed of both tissue layers found in the ectal excipulum, and is about 100 µm in width. The asci and paraphyses extend slightly above the margin (Fig. 3B,D).

In naturally produced apothecia, the margin is forced backwards, toward the flanks of the apothecium, due to the expansion of the medullary and hymenial tissues. Apothecia produced in culture do not become as repand as those in nature, thus their margins remain vertical.

SUBHYMENIUM: The subhymenium is not clearly differentiated from the medullary excipulum. It consists of ascogenous hyphae and differentiated paraphyses, and is 40-50 µm in height.

HYMENIUM: The hymenium is 150-190 µm high, and is composed of asci and circinate, anastomosing, branched

FIG. 3. Photomicrographs of *Gelatinodiscus flavidus*. A-F, apothecia collected from nature (=Carpenter 22). A-D, 10 µm vertical sections in safranin-fast green, bright-field microscopy. A. Section through a mature apothecium, × 70. B. Detail of margin and hymenium, × 180. C. Detail of stipe tissues, × 180. D. Detail of margin, × 425. E-F, squash mounts of asci in Melzer's reagent, phase-contrast microscopy. E. Detail of ascus apex demonstraing a portion of the pore cylinder and the thin region in the outer wall, × 1500. F. Ascus apex after dehiscence with evaginated pore cylinder,



× 625. G-H, squash mounts of hymenium from apothecia from NM cultures in cotton blue-lactophenol. G. Developing asci in young hymenium, bright-field microscopy, × 1330. H. Diploid nucleus in developing ascus, phase-contrast microscopy, × 1500.

paraphyses. The paraphyses are 1.5 μm wide, and terminate in a bulbous tip, 2.5-3.0 μm wide. The paraphyses extend slightly beyond the asci, and the coiling branches have a tendency to curl around the asci.

THE ASCUS

Under natural conditions, the development and maturation of asci of *G. flavidus* is simultaneous rather than seriatim. It is possible, by collecting minute ascocarps in the field, to find some of the early developmental stages of the asci. In culture, the simultaneity of ascus development does not occur, possibly due to the impreciseness of environmental stimuli in the artificial environment. Because of the above factors, it was possible to follow some of the stages of ascus development by observation of natural and cultured materials.

Asci arise from ascogenous hyphae which are thin-walled, devoid of cytoplasm as they age, 4-6 μm in width. Multiple croziers are formed from these hyphae in the subhymenium, and an intricate branching system is present in the hymenium (Fig. 3G).

Once crozier proliferation and branching has ceased, young asci, 5-7 X 2.5-3.0 μm are formed. A young ascus contains two small nuclei, and the cytoplasm appears very dark and granular in iron haematoxylin preparations. The young ascus increases in size to 30-35 X 3-5 μm; then karyogamy occurs. At this stage, the spherical nucleolus of the diploid nucleus is 2.5 μm across.

After karyogamy, the diploid nucleus migrates into the upper third of the ascus as vertical and lateral expansion of the ascus proceeds (Fig. 3H). During this process, the asci lose the dark granular appearance in iron haematoxylin preparations. When the ascus reaches about 150 X 10-12 μm, the nucleolus is 3 μm across, with a clear spot visible slightly off-center. The nuclear envelope is 8 μm across at this stage. The chromosomes of this organism have thus far proven too small to count during meiotic divisions.

Upon completion of meiosis, four small nuclei are evident in the upper third of the ascus. At this time, the apex of the ascus thickens in a hyaline region, 4-5 μm in height. After meiosis, a mitotic division of all four nuclei results in eight nuclei, surrounded by spherical walls. As the spores develop, the ascus width increases to

15-17 μm.

The mature ascus apex is 2.5-3.0 μm thick and inoperculate. The wall at the extreme upper center of the ascus appears much thinner than the rest of the wall (Fig. 3E). This thin region is 1.0 μm across and lies directly over the top of the pore plug. The pore cylinder, which surrounds the pore plug, is 2.0 μm wide at its base (located at the ascus lumen), tapering to 1.0 μm wide at the extreme tip of the ascus.

An umbraculiform region in the apex turns blue in Melzer's reagent. It consists of a shield-like, broad upper zone, which lies about 0.5 μm back from the unreactive, outermost portion of the wall, and the pore cylinder wall, which is quite distinct where it extends through the hyaline, unreactive portion of the apex (Fig. 4B). The pore plug does not appear to react in Melzer's reagent.

After ejection of ascospores, the apex appears to have been blown completely away, as illustrated by Kanouse and Smith (1940), who concluded the ascus was operculate. However, close examination of the torn apex reveals that the pore cylinder simply evaginates, along with the broadly blueing region of the apex, during dehiscence (Fig. 3F); such a process is described and illustrated for *Ciboria acerina* by Corlett and Elliott (1974), and is common in many species of the Helotiales (van Brummelen, *pers. comm.*).

THE ASCOSPORE

Development

Ascospores are cleaved-out in the upper third of the ascus following the post-meiotic mitotic division, are spherical, 10-12 μm across and uninucleate. As development proceeds, the ascospores become elliptical and are filled with a granular-appearing yellowish substance. They have a hyaline outer wall that is 1-1.5 μm thick which is smooth to somewhat irregular. The dimensions of the young elliptical ascospores are about 31 X 11 μm. Developing ascospores are at first eguttulate, becoming distinctly biguttulate as maturation proceeds.

Development of the ascospores within the ascus is at first uniseriate, the spores' long axes arranged horizontally in youth, later shifting to a vertical or subvertical position as a result of elongation, thus becoming irregularly biseriate in the mature ascus. In general, the end of the

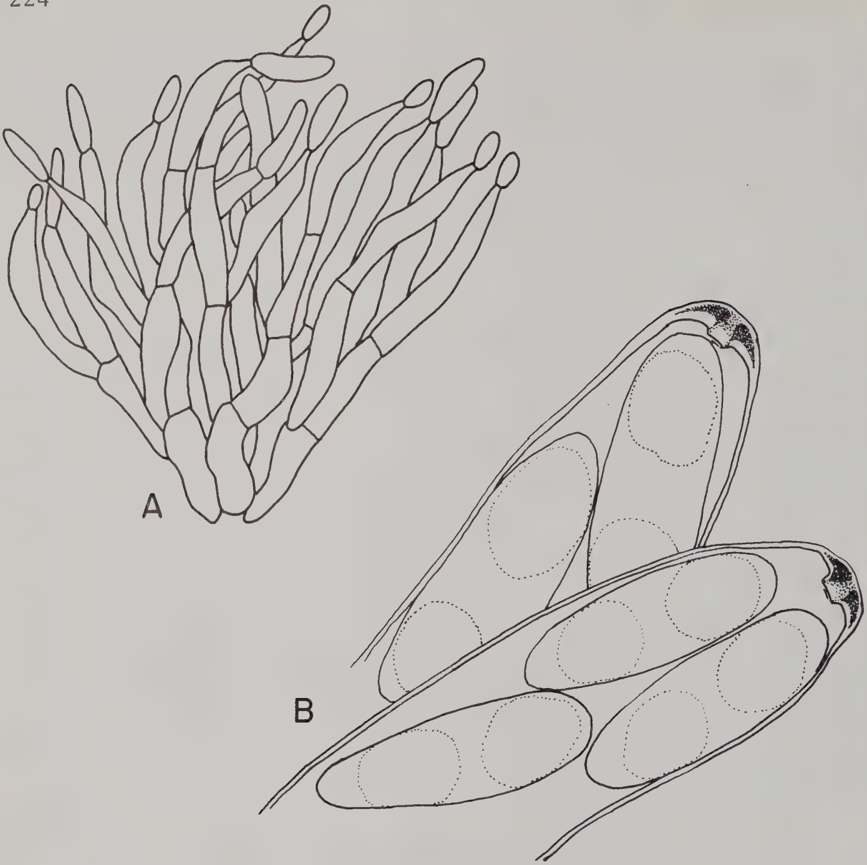


FIG. 4. Camera lucida drawing of *Gelatinodiscus flavidus*. A. Branching habit of the microconidial state, × 2700. B. Detail of ascus apex (stippling indicates iodine-positive regions), × 1770.

spore oriented toward the top of the ascus is slightly wider than the lower end (Fig. 5G,H), a phenomenon common in inoperculate Discomycetes according to Korf (1973b). Fully developed spores are 30-34 X 9-10 μm, uninucleate, with the nucleus located in the central region between the two large polar guttules (Fig. 5I). Yellowish material is present around the nucleus and guttules, giving an oily appearance. The nucleus and yellowish substance stain in cotton blue-lactophenol, safranin and iron haematoxylin. The nucleus is 3 μm across.

The mature ascospore is surrounded by a hyaline sheath, visible in India-ink mounts or under phase contrast (Fig. 5G,H). This sheath forms a 5 μm thick layer around the spore. In general, this structure is difficult to demonstrate in dried herbarium specimens unless they are allowed to rehydrate for 15 to 20 min.

Germination

The first noticeable event in germination is dispersal of the large guttules into smaller guttules. The large guttules are not lost in this process, but become noticeably smaller (Fig. 5J). At this point, the large nucleus is still visible in the central region of the spore.

Within 45 hr after ejection from the ascus (at room temperature), a small blastogenous growth emerges from the ascospore, and in most cases continues to grow into a large, sublunate, vesicular structure which soon becomes thick-walled and pigmented, and is here termed the *secondary spore* (Figs. 5J-N). Usually the secondary spore is produced slightly off-center toward either end of the ascospore; it may assume a linear or globose shape. The secondary spore is about 8 μm wide at its center, tapering to 3 μm wide at the rounded ends, and is 20-25 μm long (measured from the tip of one arm to the tip of the other). As the secondary spore grows, the cytoplasm in the ascospore can be seen to retract from the wall opposite the secondary spore and migrate into the secondary spore. As this process continues, the guttules disappear. The secondary spore is finally cut off from the ascospore by a septum, with a thin cytoplasmic connection visible between the two spores. Some cytoplasm is left within the ascospore (Fig. 5L).

Although the above description of secondary spore formation covers most instances, there is much variability in size, shape and position of the secondary spore.

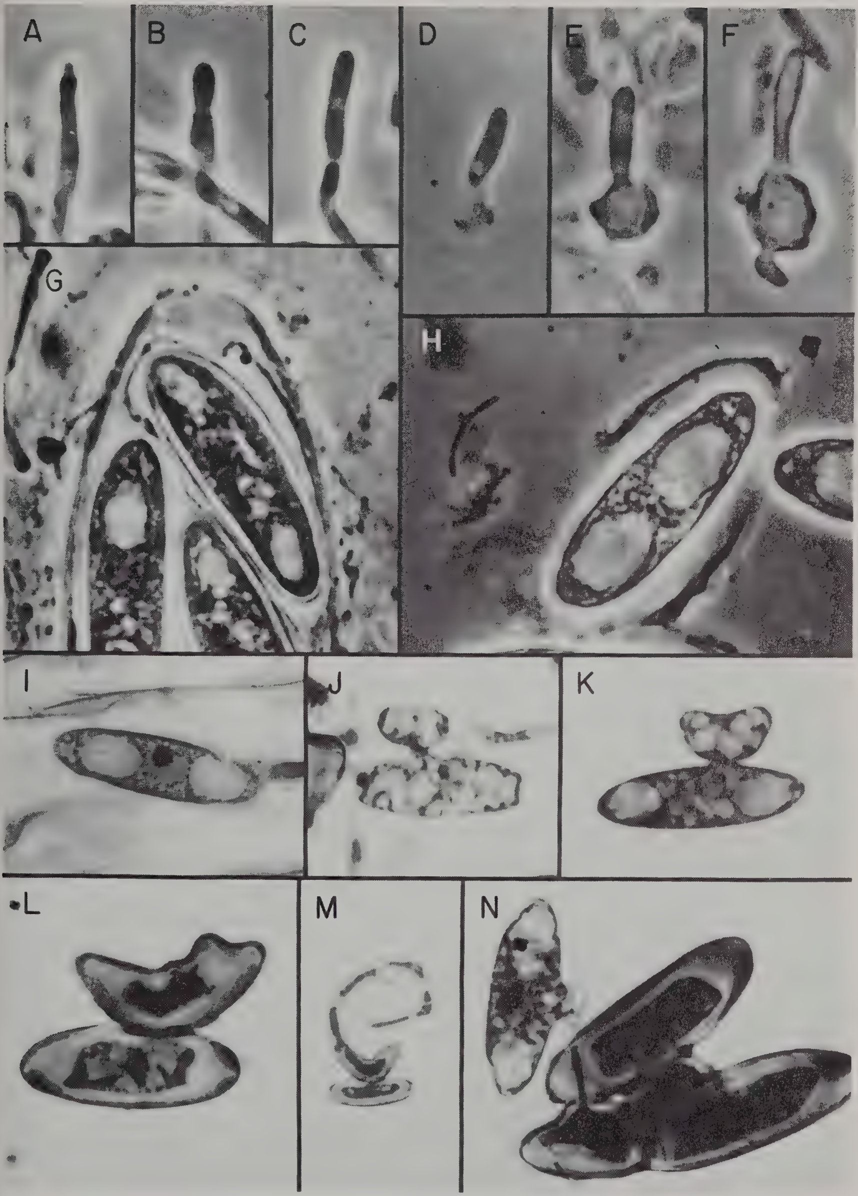
Once blastogenous development has ceased, the secondary spore and ascospore become pigmented, appearing a deep yellow-brown. In material collected from nature, nearly all ascospores germinated and both structures became pigmented with 72 hr after ejection. Ascospores produced in NM cultures often failed to germinate and did not turn brown in such instances. Other spores from the same deposit took up to one week to germinate and for the two spores to turn brown. Field-collected material produced darker pigment in the spores than culture-produced material.

After pigmentation, the secondary spore may produce either a hypha or penetration peg. If a hypha is formed, it may emerge from either the center or one of the arms of the secondary spore (Fig. 5M). Usually, the walls of the first two or three cells of such a hypha are less deeply pigmented than the walls of the spores, imperceptibly merging into hyaline cell walls as one follows the growth away from the secondary spore. After formation of 3 to 6 cells, lateral structures, resembling penetration pegs, are formed from the apical and subapical cells of the hypha. In several instances, these pegs have been observed entering hyphae produced by adjacent germinating spores. In one case, the peg produced by a terminal cell penetrated a branch produced from the subterminal cell of the same hypha.

If a hyphal system is not formed, the secondary spore may produce a penetration peg into the adjacent substrate. Undischarged ascospores may germinate by producing a secondary spore, and from that a penetration peg which pierces the ascus wall; a hyphal system can develop from such spores. Ascospores landing adjacent to each other will often each produce a secondary spore, and from each secondary spore a penetration peg will enter the adjacent ascospore (Fig. 5N).

Those ascospores placed within 1 mm of *Chamaecyparis* twigs on WA plates showed no tendency to grow in any particular direction, the fungus forming circular colonies. Secondary spores produced from ascospores placed on cellophane strips on PDA plates did not penetrate the cellophane, although the hyphae they produced did grow along the surface of the strips. Secondary spores produced from ascospores placed on cotton fibers on PDA plates did not directly penetrate the cotton, but did show a marked tendency to form hyphae which grew along and around fibers, indicating a possible thigmotrophic response.

FIG. 5. Photomicrographs of *Gelatinodiscus flavidus*. A-F, from NM cultures, squash mounts in Phloxine-B, phase-contrast microscopy, × 1370. A-C. Phialosporous development of microconidia. D. Nucleus in a microconidium. E-F. Germination of microconidia. G-H, rehydrated herbarium material, squash mounts in Melzer's reagent, phase contrast microscopy (Carpenter 222). G. Ascospore sheath surrounding the spore in the ascus, × 1440. H. Ascospore sheath in discharged spore, × 1370. I-N, material collected from nature (Carpenter 22), bright-field microscopy. I. Mature ascospore with central nucleus and polar guttules, 10 μm section in safranin-fast green, × 400. J-L. Germination of secondary spore from ascospore, in cotton blue-lactophenol, × 400. M-N, spores stained in cotton blue-lactophenol. M. Germination of hypha from secondary spore, × 160. N. Penetration peg from secondary spore entering an adjacent ascospore, × 400.


A
B
C
D
E
F
G
H
I
J
K
L
M
N

SPORODOCHIA AND MICROCONIDIA

Sporodochia, perhaps best assigned to the form-genus *Myrothecium* Tode ex Fr., appear as slimy, light yellowish to white masses on twigs in NM cultures. They are 1-2 mm across, arising from a basal mass of globose hyphae surrounded by brownish exudate. These are the first structures formed on NM cultures and appear as the water level recedes, partially exposing needles to the air.

Cells near the base of the sporodochium are 8-10 μm across, and arise from exit tubes and exit pegs produced by hyphae in the epidermal cells of the host in the same manner as primordia. The basal cells of the conidiogenous hyphae are thick-walled, 4-6 X 8-10 μm, appearing somewhat rectangular, and branching three to four times. The cells of the conidiophore become progressively smaller and lighter in color near the apex, where they end in a dichotomy (Fig. 4A).

Phialides are 18-20 X 2-2.5 μm, unbranched, slightly curved, septate and constricted near the base. In some cases, phialides are 5-8 μm in length and branched. The wall at the tipe of a phialide is somewhat thickened (Fig. 5A,B). In some cases, phialides may form intercalary, hyaline chlamydospores, similar in size and shape to chlamydospores produced by microconidia.

Microconidia are hyaline, elliptical, rounded at the apex and slightly fusoid at the base, 5-11 X 2 μm. The nucleus is visible in phase-contrast microscopy, the clear nuclear envelope bounding the contrastingly dark nucleolus (Fig. 5D). In bright-field microscopy, nuclei may be mistaken for guttules. Microconidia tend to adhere to each other in large masses.

Although no direct evidence is yet available, microconidia probably function as spermatia in sexual reproduction; trichogynes often have many microconidia attached to them, and microconidia are commonly found adhering to the base of developing apothecia.

Microconidia may produce chlamydospores at one end in a blastogenous manner (Fig. 5E,F). The chlamydospores range in size from 5 to 15 μm in diameter, and have a conspicuously wrinkled, yellowish-brown outer wall. The end of the microconidium distal to the chlamydospore will often branch and anastomose with adjacent chlamydospores. In no case were chlamydospores observed anastomosing with microconidia which had not produced a terminal chlamydospore.

It was observed that microconidia in young NM cultures did not germinate. NM cultures over 4 months old produced microconidia which germinated.

Through proliferation of additional chlamydospores, a system of hyphae is produced that strongly resembles globose cells found in old PDA cultures and those found at the base of primordia and sporodochia. It is possible that microconidia act as dispersal propagules.

DISCUSSION

Until now, *Gelatinodiscus* has been placed in the Pezizales, family Pezizaceae, by virtue of its assumed operculate nature and the blueing reaction of the asci with Melzer's reagent. Since it is now clear that this Discomycete is inoperculate, a transfer from the Pezizales must be made.

The salient features of the genus are as follows: 1) simultaneous maturation of asci; 2) inoperculate asci with a broadly blueing apex in Melzer's reagent; 3) uninucleate ascospores which turn brown after discharge; 4) a tuberculoid, phialosporic microconidial state; and 5) a simple ascocarp (an apothecium).

Simultaneous maturation of asci is relatively uncommon in the Discomycetes, being reported for the genera *Cookeina, Microstoma* and *Boedijnopeziza,* which comprise the Boedijnopezizeae of the Sarcoscyphaceae (Korf, 1972). These genera are also characterized by their J-, suboperculate asci, which differ radically from the asci of *Gelatinodiscus.* One other family, the Cyttariaceae (Cyttariales) also includes members with simultaneous ascus maturation, as reported by Korf (1973b). The ascocarp of *Cyttaria,* the sole genus in the order, is compound and in some species I have observed, the asci have a broadly blueing, inoperculate apex very like that of *Gelatinodiscus.*

Ascospores which turn brown at the time of germination are unusual and found in some genera of the Hemiphacidiaceae, Sclerotiniaceae and Leotiaceae. Some members of *Cyttaria,* which normally have hyaline ascospores in the ascus, are reported to produce black spore prints (Korf, 1973b), which indicates pigmentation following discharge. Delayed pigmentation of ascospores is common among conifer-inhabiting Discomycetes. Both *Rhabdocline* (Hemiphacidiaceae) and *Chloroscypha* (Leotiaceae) are such genera. Of special interest is the production of a secondary spore in *Chloroscypha* (Terrier, 1952; Kobayashi, 1965), which strongly resembles that produced by *Gelatinodiscus*, and of a dark germ tube in *Rhabdocline* (Brandt, 1960).

Phialosporic, tuberculoid microconidial states are known in the Helotiales and remain unreported in the Pezizales. Such states are reported for many members of the Sclerotiniaceae and the Leotiaceae. Members of the Cyttariales have a pycnidial state produced on the compound ascocarps as illustrated by Gamundi (1971).

Although a transfer of *Gelatinodiscus* from the Pezizale is indicated, proper placement of this genus within the current classification schemes remains a difficult problem. Similarities with *Chloroscypha* are striking, but probably represent adaptations to cupressaceous hosts. Certainly the structure of the ascocarp of *Gelatinodiscus* is not at all similar to that of *Chloroscypha*, the latter genus having a strongly gelatinized ectal excipulum. Although ascus structure and development strongly parallels that found in *Cyttaria*, the nature of the ascocarp is radically different.

Presently, a Discomycete with inoperculate asci and a simple, discoid apothecium with an ectal excipulum of a textura prismatica must, by definition, be placed in the Helotiales. By virtue of its developmental processes, *Gelatinodiscus* could perhaps be accommodated in the Cyttariales, but the taxonomic validity of this order remains questionable to me. Until further developmental work can be undertaken on Discomycetes showing similarities to both the Helotiales and Cyttariales, placement of *Gelatinodiscus* in the former order seems more appropriate.

The salient features of *Gelatinodiscus* are unlike any others found in the various families of the Helotiales. A new family, the Gelatinodiscaceae, is herewith proposed to accommodate this genus. It represents a family intermediate between the Leotiaceae and Cyttariaceae. The presence of broadly blueing, simultaneously maturing asci suggests strong affinities with the Cyttariaceae. Some members of the Cyttariaceae are parasitic on subalpine, evergreen *Nothofagus* in the southern hemisphere, a habitat superfically similar to that of *Gelatinodiscus* and one that may account for simila adaptations of *Cyttaria* and *Gelatinodiscus*. The simple ascocarp and tuberculoid microconidial state, on the other hand, suggest relationships with the admittedly heterogenous Leotiaceae.

FORMAL TAXONOMY

GELATINODISCACEAE Carpenter, *fam. nov.* (Helotiales)

Ascocarpus apothecium stipitatum est; asci eodem tempore omnes maturescens, non operculati, pariete pori cylindrici et parte superiore apicis incrassati asci in iodo coerulescentibus; ascospori uninucleati, hyalini vel subhyalini, utroque germinante et sporum secundarium producente, ambobus brunnescentibus.

Genus typicum: *Gelatinodiscus* Kanouse & Smith.

Ascocarp a stititate apothecium; asci maturing simultaneously, inoperculate, the pore cylinder and the upper portion of the thickened ascus apex blueing in iodine; ascospores uninucleate, hyaline to subhyaline, germinating to produce a secondary spore, both of which become brown.

SPECIMENS EXAMINED: WASHINGTON: Isotype specimen, on leaves of *Chamaecyparis nootkatensis*, Sol Duc Park Trail, Olympic National Forest, July 20, 1939, A. H. Smith 14488 (= CUP 49536). OREGON: 2 miles SW of Breitenbush Lake, near Mt. Jefferson, Willamette National Forest, July 8, 1972, S. E. Carpenter 22; 3 miles SW of Breitenbush Lake, May 14, 1973, S. E. Carpenter 222 (= CUP 54529); At the summit of Iron Mountain, Santiam Pass, Lane County, 1700 m., May 18, 1973, S. E. Carpenter 225.

ACKNOWLEDGEMENTS

The author expresses his gratitude to the Department of Plant Pathology and the Graduate School of Cornell University for their support during his studies.

Appreciation is extended to Dr. Richard P. Korf for his advice and criticism and for serving as Chairman of the author's Special Committee. Thanks are also due Dr. W. A. Sinclair for serving as a member of the Special Committee and for his advice.

Thanks are extended to Dr. W. C. Denison, Oregon State University, for first arousing my interest in the Discomycetes and for his encouragement during the preliminary stages of this study.

LITERATURE CITED

BRANDT, R.W. 1960. The *Rhabdocline* needle cast of Douglas-fir. State University College of Forestry, Syracuse Univ., Tech. Publ. 84: 1-66.

COOKE, W.B. 1955. Subalpine fungi and snowbanks. Ecology 36: 124-130.

CORLETT, M. and M.E. ELLIOTT. 1974. The ascus apex of *Ciboria acerina*. Can. J. Bot. 52: 1459-1463.

DENNIS, R.W.G. 1968. British Ascomycetes. Cramer, Lehre.

ECKBLAD, F.-E. 1968. The genera of the operculate Discomycetes: a re-evaluation of their taxonomy, phylogeny and nomenclature. Nytt Mag. Bot. 15: 1-191.

FRENKEL, R.E. 1974. An isolated occurrence of Alaska-cedar *(Chamaecyparis nootkatensis* (D. Don) Spach*)* in the Aldrich Mountains, central Oregon. Northwest Sci. 48: 29-37.

GAMUNDÍ, I.J. 1971. Las "Cyttariales" Sudamericanas. Darwiniana 16: 461-510.

HEPTING, G.H. 1971. Diseases of forest and shade trees of the United States. USDA Forest Service Handbook No. 386.

HUGH, R. and E. LEIFSON. 1953. The taxonomic significance of fermentative versus oxidative metabolism of carbohydrates by various Gram-negative bacteria. J. Bacteriol. 66: 24-26.

JENSEN, W.A. 1962. Botanical histochemistry. W.H. Freeman and Co., San Francisco and London.

KANOUSE, B.B. and A.H. SMITH. 1940. Two new genera of Discomycetes from the Olympic National Forest. Mycologia 32: 756-759.

KOBAYASHI, T. 1965. Taxonomic notes on *Chloroscyphae* causing needle blight of Japanese conifers. Bull. Govt. Forest Exp. Sta. (Tokyo) 176: 55-74.

KORF, R.P. 1965. Japanese Discomycete notes XVII. On *Ascobolus denudatus* (Pezizaceae, Ascoboleae). Trans. Mycol. Soc. Japan 6: 74.

____. 1972. Synoptic key to the genera of the Pezizales. Mycologia 64: 937-994.

____. 1973a. On Boudier's genus *Lepidotia* (Pezizaceae). Persoonia 7: 205-212.

____. 1973b. Chapter 9. Discomycetes and Tuberales. *In* Ainsworth, G.C., F.K. Sparrow and A.S. Sussman [eds.], The Fungi: an advanced treatise. A taxonomic review with keys: Ascomycetes and Fungi Imperfecti. IVA: 249-319. Academic Press, New York and London.

SAGARA, N. 1974. Studies on the ammonogenous fungi. Ph.D. Thesis, Kyoto University, Kyoto, Japan.

SEAVER, F.J. 1942. The North American cup-fungi (Operculates), suppl. ed. Seaver, New York; reprinted 1961, Hafner, New York.

____. 1951. The North American cup-fungi (Inoperculates). Seaver, New York; reissued as spurious "supplemented edition," 1961, Hafner, New York.

TERRIER, C. 1952. Duex Ascomycètes nouveaux. Ber. Schw. Bot. Ges. 62: 419-428.

MYCOTAXON

Vol. III, No. 2, pp. 233-238 January-March 1976

THE GENUS PLATYSTICTA

MARTHA A. SHERWOOD

Plant Pathology Department, Cornell University

Ithaca, N.Y. 14853

SUMMARY

The type species of *Platysticta* Cooke is an abnormal, muriform-spored variant of *Lichenopsis sphaeroboloidea* Schw. and the genus *Platysticta* falls into synonymy with *Lichenopsis*. The other included species is here transferred to *Ocellularia*. Other muriform-spored fungi in the Ostropales are discussed.

Cooke (1889), in a discussion of *Lichenopsis* Schw., mentioned a fungus, communicated by Ravenel and deposited in the Berkeley herbarium as #2423, having the external appearance of *L. sphaeroboloidea* Schw. and differing only in having muriform spores which came apart at the septa. This fungus was described as a new species, *Platysticta simulans* Cooke and Massee. From Berkeley and Broome's (1875) description of *Platygrapha magnifica* Berk. and Br., Cooke concluded that that species was congeneric and transferred it to *Platysticta*. The character of spores which came apart at the septa was stressed.

Cooke failed to indicate a type for his genus. Saccardo (1889) lectotypified *Platysticta* by transferring *P. magnifica* (Berk. & Br.) Cooke to *Lichenopsis* and retaining *P. simulans* in *Platysticta* [cfr. Korf and Rogers (1967)]. This choice of type was followed by Clements and Shear (1931), who synonymized the genus with *Melittosporium* Corda.

Examination of an apparent isotype of *P. simulans*, Curtis #2423 (FH as *Lichenopsis sphaeroboloidea*) = Ravenel Fungi Caroliniani I:72 p.p. , reveals a fungus which agrees in all characters except the muriform spores with *L. sphaeroboloidea*. *L. sphaeroboloidea* is easily distinguished from other Sticti-daceous fungi by periphysoids which stain J+ blue in Melzers reagent*, and by knoblike brown paraphyses tips. The specimen also agrees with Schweinitz's species in other respects, such as the thickness of the ascus cap and the shape of the pore, tardy and irregular dehiscence of the ascocarp, and poorly developed crystalline layer in the margin. Size of spores, and number of spores per ascus, are both extremely variable. I see no evidence that the cells separate at the septa at maturity.

---

*All specimens were rehydrated in water and sectioned on a freezing microtome.

Figure 1 illustrates Ravenel Fungi Caroliniani II - 54 (CUP-D-6326), which was issued as *Stictis pupula* Fr. but is *P. simulans*.

Examination of the other species of *Platysticta, P. magnifica,* reveals that it is a typical Thelotremataceous lichen referable to the genus *Ocellularia*. It is accordingly transferred to that genus and briefly redescribed.

OCELLULARIA MAGNIFICA (Berk. & Br.) Sherwood comb. nov.(Fig. 2)

≡ *Platygrapha magnifica* Berk. & Br. J. Linn. Soc. Bot. *14:*110. 1875

≡ *Platysticta magnifica* (Berk. & Br.) Cooke & Massee Grevillea *17:* 94. 1889

Thallus thin, entirely within the substrate, indicated by a greenish-yellow discoloration of the bark. Apothecia 2-5 mm in diameter, bright orange, not sunken in thalloid warts, with a dark margin composed mainly of discolored bark. Columella absent. The orange color is derived from the orange color of the bark beneath the hymenium rather than from hymenial pigments. Paraphyses scarcely exceeding the asci, 1.0μm thick, 1-2 times branched above, giving the apothecial disc a pruinose appearance. Asci 150-160 x 14-18μm, very thick walled when young, moderately thick walled when mature, with an apical cap 5-6μm thick. Hymenium J-. Spores 100-120 x 10-12μm, circa 20-septate with lenticular cells, staining faintly purple in Melzer's reagent.

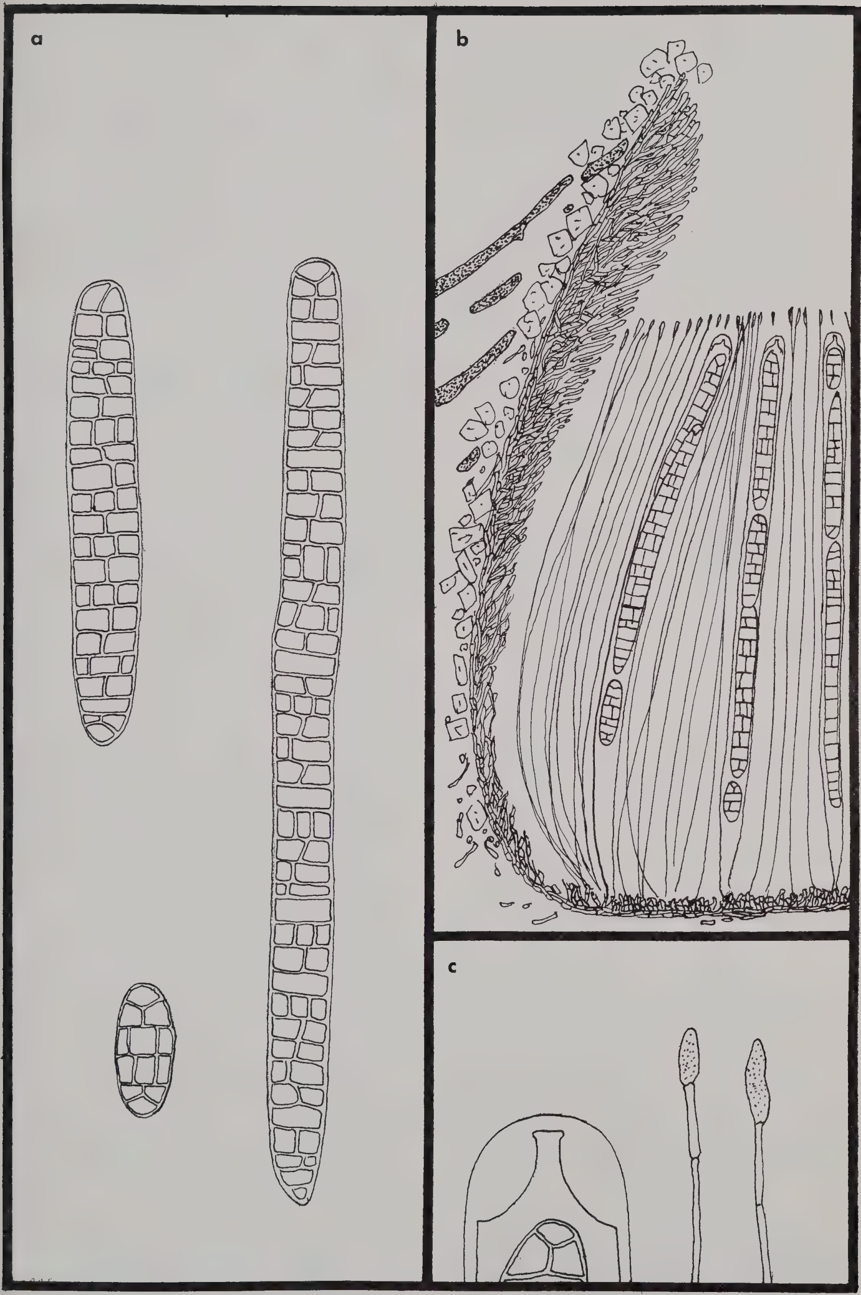
TYPE: (Herb. K) D. Thwaites, Ceylon. "C. L[eighton]204 (624 to Berk."

In this material many asci contain spores some of whose cells are disintegrating or aborted. Evidently Berkeley interpereted this as disarticulation at the septa.

The above species has a distinct, although inconspicuous thallus, and this, as well as the characteristic spores with lenticular cell lumen and walls which stain purple in iodine solutions, place it unambiguously in the Thelotremataceae, a family considered by many lichenologists to belong in the Ostropales. All known representatives of the non-lichenized Ostropales [Ostropaceae, sensu Nannfeldt(1932)], and the Lichen genus *Conotrema* Tuck., whose resemblance to *Stictis* Pers. has been well documented (Gilenstam, 1974), have spores with a cylindrical cell lumen and thin or uniformly thickened

---

Figure 1. *Platysticta simulans.* a. Ascospores, x750. b. Vertical section at the margin, x225. c. Apex of ascus and two paraphyses, x1500. Drawn from CUP-D-6326.


a
b
c

walls which do not stain purple in iodine solutions. *Platysticta simulans,* and the unnamed fungus mentioned below, have spores of the latter type, and this, coupled with the close resemblance between *P. simulans* and *Lichenopsis,* excludes the Lichen genus *Thelotrema* Ach., with colorless muriform spores, from the list of possible synonymns for *Platysticta.*

Muriform spores occur elsewhere in the Ostropales. Gilenstam (1974) illustrates *Conotrema harmandii* (Pitard) Gilenstam, a muriform-spored species known from two collections on *Ilex* from the Canary Islands. Judging from the detailed descriptions provided, this species is very close to the phragmosporous *Conotrema urceolatum* Tuck.

Figure 3 illustrates a fungus (CUP 54717) collected near Austin, Texas. In this case the normal form, presumably a small *Stictis*, is unknown. The sequence of septation in the muriform spores is unlike that in *Thelotrema,* in which the immature spores resemble those of *Ocellularia* as shown in figure 2-b.

The genus *Platysticta,* which is typified by *P. simulans,* an abnormal form of *Lichenopsis sphaeroboloidea,* is based primarily on a misinterpretation (that the spores of the two species disarticulate at the septa), is not synonymous with *Melittosporium,* and should be treated as a synonymn of *Lichenopsis.*

ACKNOWLEDGEMENTS

The author wishes to thank J. P. M. Brennan (K) for loaning specimens, R. T. Jackson for his collection (CUP 54717) from Texas, Don Pfister (FH) for specimens and helpful bibliographic suggestions, and R. P. Korf for help in preparing the manuscript.

LITERATURE CITED

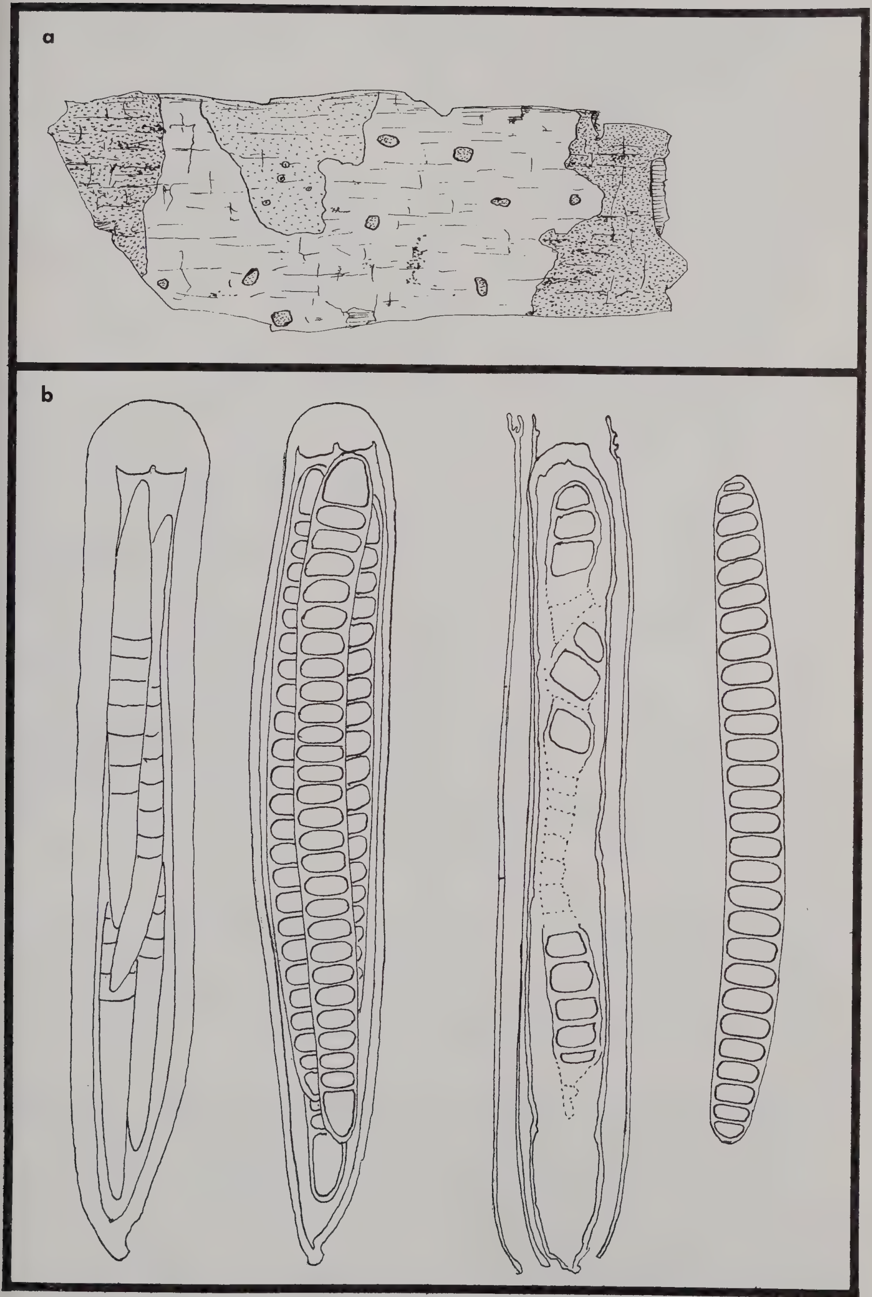
Berkeley, M. J., & C. Broome (1875). Enumeration of the Fungi of Ceylon II. J. Linn. Soc. Bot. *14:*29-140.

Clements, F. C., & C. L. Shear (1931). The Genera of Fungi. New York, H. H. Wilson Co. iv+496p.,58pl.

Cooke, M. C. (1889). What is Lichenopsis? Grevillea *17:*93-96.

Gilenstam, Gunnar (1974). Studies in the lichen genus Conotrema. Ark. Bot. *7*(2-3):149-179.

FIGURE 2. *Ocellularia magnifica.* a. Habit sketch, x0.75. b. Immature, mature, and disintegrating asci, and a mature ascospore, x750. Drawn from the type.


a
b

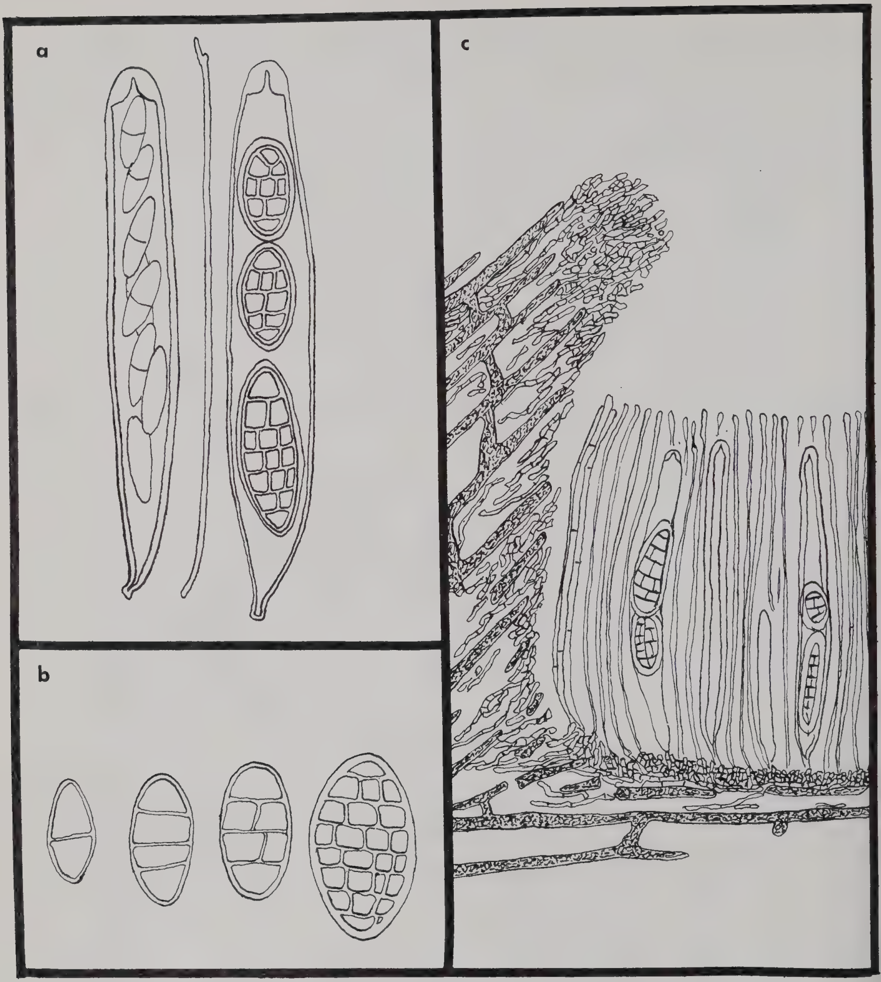


FIGURE 3. *Stictis?* sp. a. Young and mature asci, and a paraphysis, x750. b. Stages in ascospore maturation, x750. c. Vertical section at the margin, x375. Drawn from CUP 54717

Korf, R. P. & J. K. Rogers (1967). A new term, the schizotype and the concept of implicit typification. Taxon *16:*19-23

Nannfeldt, J. A. (1932). Studien über die Morphologie und Systematik der nicht-lichinisierten inoperculaten Discomyceten. Nova Acta Regiae Soc. Sci. Upsal. IV.*8*.2: 1-368

Saccardo, P. A. (1889). Sylloge Fungorum 8. Patavii. 1-1143.

MYCOTAXON

Vol. III, No. 2, pp. 239-260 January-March 1976

SPECIFIC AND INFRASPECIFIC NAMES FOR FUNGI USED IN 1821.

PART III. D - G.[1]

RONALD H. PETERSEN

Department of Botany, University of Tennessee
Knoxville, Tennessee 37916 *USA*

Summary

Data on publication dates of several 1821 and pre-1821 works are reviewed, additional pre-1821 literature is listed, and appropriate fungus names, D-G, are summarized.

Since publication of the last portion of this review series, no additional 1821 literature has been uncovered (but see below). In a letter, however, Dr. D. P. Rogers has brought forward several facts not previously known to me, and has generously allowed me to use the information here.

1. Persoon, C. H. "1822." Abhandlung über die essbaren Schwämme. Heidelberg. [Translation by J. H. Dierbach]. This volume was mentioned in Hinrichs Verzeichnis. 1821. July-December, page 68, indicating possible appearance in 1821.

2. ENA and NNA (see part 1 of this series for codes) appeared in part I of "Nova Acta." Volume 10 was distributed in two parts, apparently divided by a rule before the title beginning on page 257. The first part was mentioned in the following:

Sprengel, K. 1822. Neue Entdeckung im ganzen Umfang der Pflanzenkunde 3: 283-285.

As "Tom 10. Pars I. Bonn. 1820. 254 S. in Quart." These two references (ENA, NNA) therefore, may be pre-1821.

3. The following has not been seen by me, and I request any information or xerox copy of appropriate pages.

---

[1] This paper represents contribution no. 457 from the Botanical Laboratories, University of Tennessee.

Capelli, C. 1821. Catalogus stirpium quem aluntur in Regio Horto Botanico Taurinense. Augstae [sic] Taurinorum.

4. POM 2, dated by me as 1799 (from the title page), also bears the following on the leaf facing the title page: "Animadversiones et dilucidationes circa varias fungorum species ... 1800." The date of publication, therefore, is uncertain.

5a. The *latest* date of publication of Gray's "Natural Arrangement" was December 21, 1821, minus time for delivery from London to Glasgow.

b. Hooker's "Flora Scotica" was published *no later* than May 10, and *after* April 10. The relative appearance dates of Hooker and St.-Amans are therefore uncertain.

6. Some copies of FO 2 include an introduction. Full citation should include X + 376 pp + pls. V-VIII.

7. PD was first published as "Dispositio methodica fungorum" in "Neues Magazin für die Botanik (Römer) 1: 81-128, pls. I-IV. 1794." With only a change in pagination, this became pages 1-48 of "Tentamen." Pages 49-76 were a supplement to this.

Noting my confusion over the publication dates of Bulliard's plates (see part II of this series), Dr. G. C. Ainsworth kindly has referred me to the following two references, which have proved of much help in this and the related matter:

Gilbert, E. J. 1952. Un espirit - une oeuvre. Bulliard, Jean Baptiste Francois, dit Pierre (1752-1793). Bull. Soc. Mycol. France 68: 5-131.

Ramsbottom, J. 1933. Dates of publication of Sowerby's English Fungi. Brit. Mycol. Soc. Trans. 18: 167-170.

In addition the following can also be supplied:

Dick 2: 25 *sub Clavaria farinosa* cites HBR. Both were published ostensibly in the same year, but obviously HBR appeared before Dick 2. Moreover, Dick 2 was reviewed in Ann. Bot. 4: 101. 1793.

More pre-1821 Mycological Literature

Agh Agardh, Caroli A. 1817. Synopsis algarum scandinaviae. xl + 135 pp.

All Allioni, Carolo. 1785. Flora Pedemontana sive enumeratio methodica stirpium indigenarum pedemontii.
Tom. 1. Augustae Taurinorum. xix + 344 pp.
Tom. 2. Augustae Taurinorum. 366 pp.
[fungi: 337-360] + xxiv indexes
Tom. 3. Augustae Taurinorum. xiv + 94 pls.

Brot Brotero, Felicis Avellar. 1804. Flora Lusitanica, seu plantarum, quae in Lusitania vel sponte crescunt, vel frequentius coluntur, ex florum praesertim sexubus systematice distributarum, synopsis. Olissipone.
Vol. 1. xviii + 607 pp.
Vol. 2. 557 pp.

BrP Brotero, F. A. Phytographia Lusitaniae selectior, seu novarum, rariorum, et aliarum minus cognitarum stirpium, quae in Lusitania sponte veniunt, ejusdemque floram spectant, descriptiones iconibus illustratae. Olisipone.
Tom. 1. 1816. 235 pp + 82 pls.
[Tom. 2. 1827. 263 pp + pls. 83-181.]

Ehren Ehrenberg, C. G. 1818. Sylvae mycologicae Berolinenses. Berolini. 32 pp + 1 pl.
[Asher reprint, 1972]

GUN Gunner [i], Jo. Ern. Flora Norvegica, observationibus praesertim oeconomicis, panosque norvegici locupletata.
Pars prior. 1766. Nidrosiae. 96 pp + index
Pars posterior. 1772. Hafniae. 148 pp + index + 9 pls.

Holm Holmskjold, T. 1796. Coryphaei. Clavarias Ramariasque complectentes cum brevi Structurae interioris Expositione. Neue Ann. Bot., Usteri 11: 30-149.

Mey Meyer, Georgio Friderico Wilhelmo. 1818. Primitiae Florae Essequeboensis adjectis descriptionibus centrum circiter stirpium novarum, observationibusque criticis. Gottingae. 316 pp + 2 pls.

PAB Persoon, C. H. 1794. Nähere Bestimmung und Beschreibungen einiger sich nahe verwandter Pflanzen. Neue Ann. Bot., Usteri 5: 1-32.

Paul Paulet, Jean Jacques. 1793. Traité des champignons, ouvrage dans lequel, on trouve aprés l'histoire analytique and chronologique des découvertes and des travaux fur ces plantes, fuivie de leur synonimie botanique and des tables nécessaires, la description détaillée, les qualités, les effets, les différens usages non-seulement des champignons proprement dits, mais des truffes, des agarics, des morilles, and autres productions de cette nature, avec une fuite d'expériences tentées fur les animaux, l'examen des principes pernicieux de certaines espèces, and les moyens de prévenir leurs effets ou d'y remédier; le tout enrichi de plus de deux cents planches où ils sont représentés avec leurs couleurs and en général leurs grandeurs naturelles, and distribués suivant une nouvelle méthode. Paris.
Vol. 1. 629 pp.
Vol. 2. 476 pp + index

[Virtually no Latin names are used in the body of the text, but such names can be found and correlated, with difficulty, in the index. Copy at NY.]

PNT Pici, Victorii. 1788. No overall title, but see below. Augustae Taurinorum. 283 pp + 2 pls.
[This appears to be a thesis defended in Taurin, with the following chapter headings:
Ex physica de fungorum generatione
Ex materia medica de fungis
Ex anatome deglutitionis organa
Ex physiologia deglutitio
Extheorica de symptomatibus quae fungorum venanatorum esum consequi solent
Ex praxi de ratione medendi iis qui a fungis veneficis male habent]

Poll Pollini [us], Cyrus. 1816. Horti et provinciae Veronensis plantae novae vel minus cognitae, quas descriptionibus et observationibus exornavit.
Facs. 1. Ticini. 39 pp + 2 pls.
[Reprint from: Giorn. Fisica, Chim. and Stor. Nat. Med. and Arti di Pavia, vol. 9. Copy at NY bound separately]

RC Roth, Alberto. [Albrecht] Guilielmo. Catalecta botanica quibus plantae novae et minus cognitae describuntur atque illustrantur.
Vol. 1. 1797. Lipsiae. viii + 251 pp.
Vol. 2. 1800. Lipsiae. 258 pp.
Vol. 3. 1806. Lipsiae. 350 pp [no fungi]

REB Rebentisch, Joanne Frid. 1805. Index plantarum circum Berolinum sponte nascentium adiectis aliquot fungorum descriptionibus. Berolini. iv + 46 pp.
[Copy at NY]

Relh Relhan, Richard. 1785. Flora Cantabrigiensis, exhibens plantas agro Cantabrigiensi indigenas, secundum systema sexuale digestas, cum characteribus genericis, diagnosi specierum, synonymis selectis, nominibus trivialibus, loco natali, tempore inflorescentiae. Cantabrigiae. introd. + 490 pp.

RelS Relhan, Richard. Florae Cantabrigiensi supplementum.
Supplement. 1786. Cantabrigae. 39 pp.
Supplementum Alterum. 1788. Cantabrigiae. 36 pp.
Supplementum tertium. 1793. Cantabrigiae. 44 pp.
[All parts include fungi. Bound together with Relh at NY.]

Rum Rumphius, Georgii Everhardi. Herbarium Amboinense, plurimas conplectens arbores, frutices, herbas, plantas terrestres and aquaticas, quae in Amboina, et adjacentibus reperiuntur insulis, adcuratissime descriptas juxta earum formas, cum diversis denominationibus, cultura, usu, ac virtutibus. Quod and insuper exhibet varia insectorum animaliumque

genera, plurima cum naturalibus eorum figuris depicta. Omnia magno labore ac studio multos per annos conlecta, and duodecim conscripta libris. Nunc primum in lucem edita, and in Latinum sermone versa.
Pars sexta. Amstelaedami. 1750.

Scop Scopoli, Joannis Antonii. 1772. Flora Carniolica, exhibens plantas Carnioliae indigenas et distributas in classes, genera, species, varietates, ordine Linnaeano.
Tom. II. Vindobonensis. 496 pp + index + pls. 33-65.

SIN Swartz, Olavi. 1797. Flora Indiae Occidentalis aucta atque illustrata sive descriptiones plantarum in prodromo rescensitarum. Erlangae. 1940 pp.
[Continuously paged in 4 volumes. Fungi: pp. 1920-1940. Copy at NY]

SMH Schmidt, J. C. 1817. Neue Arten, von der Herausgebern beschreiben. Mykol. Hefte 1: 67-92.

TRAT Trattinnick, Leopoldus. Fungi Austriaci, iconibus illustrati Descriptiones ac historiam naturalem completans. [Also: "Oesterreichs Schwämme, in sein ausgemahlten Abbildungen dargestellt."]
Lieferung 1. "1805" [1804] Wien. 35 pp.
Lieferung 2. 1805 Wien, Baden, Triest pp. 37-76
Lieferung 3. 1805 Wien, Baden, Triest pp. 77-98
Lieferung 4. 1805 Wien, Baden, Triest pp. 99-124
Lieferung 5. 1805 Wien, Baden, Triest pp. 125-154
Lieferung 6. 1806 Wien, Baden, Triest pp. 155-202

[The following notes occur in the NY copy: "Lieferung 1-4 had appeared before 15 May 1805 (see Bot. Zeit. Regensb. 4: 202-204. 15.v.1805). *Probably* the entire work appeared in 1805, except the last lieferung, and this in 1806." "In his introduction to the 2nd edition, the author states that lief. 1 appeared toward the end of 1804 - D. P. R[ogers]."]

WEB Weber, Georgii Henrici. 1778. Spicilegium florae Goettingensis. Plantas inprimis cryptogamicas hercyniae illustrans. Gothae. Introd. + 288 pp + index + 5 pls.

-- D --

dasypus (Agaricus) Fr: 50 ← [PS: 348]
dealbatus (Agaricus) Fr: 92, not 93 ← [SEF: no. 123, pl. 123]
decastes (Agaricus) Fr: 49 ← [FO 2: 105]
decipiens (Agaricus) Fr: 236 ← [PS: 298-299]
decipiens (Hydnum) SA: 546 ← [DC 2: 112-113]
decipiens (Sphaeria) M: 139 ← [DC 2: 285]
decolorans (Agaricus) Fr: 56, nom. nov
decolorans (Sphaeria) FSS: no. 184, H: 6-7 ← [PD: 3 :] Fr 2: 412
decomponens (Sphaeria) G: 530 ← [SEF: no. 217, pl. 217]
decorticans (Sphaeria) P: 279, Schl: 59 ← [SEF: no. 137, pl. 137 † "decorticata"]
decorticata (Nemania) G: 517 ← [SEF: no. 137, pl. 137 (Sphaeria)]
decorticata (Sphaeria stigma [var.]) H: 5 ← [SEF: no. 137, pl. 137 (Sphaeria ____)]
decorus (Agaricus) Fr: 108, nom. nov.
delicata (Clavaria subtilis [var.]) Fr: 475, var. nov.
delicatus (Agaricus) Fr: 23, sp. nov.
deliciosus (Agaricus) Fr: 67, R: 28, N&B: 325, SA: 564-565, L: 472, P: 188-189, M: 54 ← [LSpPl: 1641]
deliciosus (Agaricus lactifluus) Z: 314 † ← [LSpPl: 1641 (Agaricus ____)]
deliciosus (Agaricus (Lactifluus)) K: 8-9 ← [LSpPl: 1641 (Agaricus ____)]
deliciosus (Lactarius) G: 624 ← [LSpPl: 1641 (Agaricus)]
deliquescens (Agaricus) (as "A. copr. ____"): Fr: 309 ← [BH: 409, pl. 558, fig. 1]
deliquescens (Agaricus) SA: 568, N&B: 320, M: 57 ← [BH: 409, pl. 437, fig. 2, pl. 558, fig. 1]
deliquescens (Tremella) P: 177-178, M: 28, SA: 536 ← [BH: 219, pl. 455, fig. 3]
dematium (Sphaeria) FSS no. 202 ← [PS: 88]: Fr 2: 505
demissus (Agaricus) Fr: 157, sp. nov.
dendritica (Byssus) G: 552 ← [Agh: 96 (Conferva)]
dendroides (Botrytis) M: 14, N&B: 367 ← [BH: 105, pl. 504, fig. 9 (Mucor)]
denigratus (Agaricus) Fr: 30 ← [PS: 267]
dentatum (Phacidium) Schl: 58 ← ["Moug[eot]"]
dentatus (Agaricus) HFD 12: t. 1735, fig. 2 ← [Sae 2: 284]
denticulatus (Agaricus) Fr: 112 ← [Sae 2: 327]
denticulatus (Agaricus pratella) Z: 312 † ← [Bolt: 4, pl. 4 (Agaricus ____)]
denticulatus (Prunulus) G: 630 ← [Bolt 4: pl. 4 (Agaricus)]
depallens (Agaricus) Fr: 58 † ← [PS: 440]
depexus (Agaricus) Fr: 230 ← [FO 2: 53]

depluens (Agaricus) Fr: 275 ← [BEFC 1: 167, pl. 122]
depressa (Sphaeria) P: 490 ← [Bolt: 122, pl. 122, fig. 1]
depressum (Peripherostoma) G: 515 ← [Bolt: 122, pl. 122, fig. 1 (Sphaeria)]
depressum (Peripherostoma fuscum [var.]) G: 514, var. nov.
destructor (Polyporus) Fr: 359 ← ["Schrader spic. 166" (Boletus)]
destruens (Poria) G: 639, nom. nov. ← ["Schrader spic. 166" (Boletus "destructor")]
destruens (Serpula) G: 637 ← [PS: 496]
detonsus (Agaricus) Fr: 232, sp. nov.
deusta (Nemania) G: 516 ← [Hoffm 1: 3, pl. 1, fig. 2 (Sphaeria)]
deusta (Sphaeria) LD 22: 386, Schl: 59, H: 5, M: 138, SA: 520, N&B: 297 ← [Hoffm 1: 3, pl. 1, fig. 2]
devexus (Agaricus) Fr: 158 †, sp. nov.
diaphana (Odontia) G: 651 ← ["Schrader spic. 178" (Hydnum)]
diaphana (Pistillaria) Fr: 498 ← [Sae 2: 405 (Clavaria)]
diaphanum (Hydnum) Fr: 418 ← ["Schrader spic. 178"]
diatretus (Agaricus) Fr: 83 ← [FO 2: 200]
dichotoma (Rhizomorpha) P: 306 ← [SEF: no. 298, pl. 298]
dichrous (Agaricus) Fr: 202 ← [PS: 343]
dichrous (Polyporus) Fr: 364 ← [FO 1: 125]
dicksoni (Mitrula) G: 660, sp. nov.?
dictyorhizus (Agaricus) Fr: 192 ← ["DC 2: 594" - not found]
difforme (Geoglossum) Fr: 489 ← [FO 1: 159]
difformis (Agaricus) Fr: 170 ← [PS: 462]
diffusa (Nemania) G: 517 ← [SEF: no. 373, pl. 373, fig. 10 (Sphaeria)]
digitaliformis (Agaricus) M: 57, N&B: 321, L: 472 ← [BH: 435, pl. 22, pl. 525, fig. 1]
digitata (Monilia) SA: 527, L: 466 ← [PS: 693]
digitata (Mucor) H: 34 ← [PS: 693 (Monilia)]
digitata (Monilia penicillata var. Mucor ____) M: 14 † ← [PS: 693 (Monilia ____)]
digitata (Sphaeria) Schl: 59, P: 495, SA: 520 ← [LSpPl: 1652 (Clavaria)]
digitatiformis (Agaricus) SA: 567 ← [BH: 435, pl. 525, fig. 1, "digitaliformis"]
digitatum (Hypoxylon) G: 513, M: 138 ← [LSpPl: 1652 (Clavaria)]
digitatum (Xylodon) G: 649 ← [PS: 553]
dillwynii (Typhoderma) G: 559, nom. nov.
dimidiata (Helvella) P: 238 ← [BH: 290, pl. 498, fig. 2]
dimidiatus (Agaricus inconstans var.) M: 51 ← [Sch 4: 57 (Agaricus ____)]
dimidiatus (Agaricus inconstans [var.]) SA: 560 ← [Sch 4: 57 (Agaricus ____)]

disciforme (Corynium) Schl: 57 ← ?
disciformis (Nemania) G: 518 ← [Hoffm 1: 15, pl. 4, fig. 1 (Sphaeria)]
disciformis (Sphaeria) N&B: 298, H: 5, Schl: 59, M: 141 ← [Hoffm 1: 15, pl. 4, fig. 1]
disciformis (Thelephora) Fr: 443, Schl: 59 ← [DC 6: 31]
discoideus (Agaricus) Fr: 33 ← [PS: 365]
discolor (Hydnum) Fr: 411, nom. nov.
dispersa (Sphaeria) Schl: 59, sp. nov.?
dispersa (Thelephora) Schl: 59, sp. nov.?
disseminatus (Agaricus) Fr: 305 ← [PCS: 87]
disseminatus (Agaricus coprinus) Z: 113 † ← [PCS: 87]
disseminatus (Coprinus) G: 634-635 ← [PCS: 87 (Agaricus)]
ditopus (Agaricus) Fr: 171 ← [FO 1: 91 †]
diversidens (Hydnum) Fr: 411, sp. nov.
djamor (Agaricus) Fr: 185, not 188 ← ["Fries" ← Rum 5: 125 "djanior" †]
doliolum (Sphaeria) H: 7, P: 283, ← [PIC 2: 39, pl. 10, figs. 5, 6]
doliorum (Sphaeria) Schl: 59 ← [PIC 2: 39, pl. 10, figs. 5, 6, "doliolum"]
domestica (Himantia) Schl: 57, LD 21: 164 ← [PS: 703]
domestica (Peziza) G: 666 ← [SEF: no. 351, pl. 351]
domestica (Thelephora) Fr: 451 ← [PS: 703 (Himantia)]
domesticus (Agaricus) P: 232 ← [Bolt: 26, pl. 26]
domesticus (Agaricus, as "A. copr. ____") Fr: 311 ← [Bolt: 26, pl. 26 (Agaricus ____)]
domesticus (Coprinus) G: 635 ← [Bolt: 26, pl. 26 (Agaricus)]
dorsalis (Agaricus) Fr: 184 ← [Bosc: 85, pl. 4, fig. 4]
dryadeus (Boletus) G: 642 ← [PS: 537 (B. fomentarius [var.] ____) ← POM 2: 3 (B. "drijadeus")]
dryadeus (Polyporus) Fr: 374 ← [POM 2: 3, (Boletus "drijadeus")]
dryina (Sphaeria) G: 529 ← [PS: 58]
dryinus (Agaricus) Fr: 180 ← [PCS: 96]
dryophilus (Agaricus) Fr: 124, Schl: 56, SA: 573, M: 66, G: 612 ← [BH: 470, pl. 434]
dryophillus (Agaricus) H: 24, P: 228-229 ← [BH: 470, pl. 434 "dryophilus"]
dubia (Tremella amethystea var.) M: 28 ← [PCS: 127 (Acrospermum ____)]
dubia (Nemaspora) G: 532 ← [SEF: no. 375, pl. 375, fig. 7 (Sphaeria)]
dubium (Coryne) G: 595 ← [PCS: 127 (Acrospermum)]
dulcis azonus (Agaricus subdulcis var.) M: 54 † ← [not BH: 493]
dulcis zonatus (Agaricus subdulcis var.) M: 54 † ← [not BH: 493]
dunaldi (Agaricus) SA: 575 ← [DC 6: 47, "dunalii"]
dunalii (Agaricus) Fr: 176 ← [DC 6: 47]

duplex (Exormatostoma) G: 523 ← [SEF: no. 375, pl. 375, fig. 4 (Sphaeria)]
dura (Daedalea quercina [var.]) G: 638, var. nov.?
durum (Sclerotium) FSS: 218, Schl: 59, SA: 617, H: 10 ← [PAB: 31]
dycmogalus (Agaricus) M: 53, L: 472, SA: 563 ← [BH: 503, pl. 584]
dyctiorhysus (Agaricus) M: 87 ← ["DC 2: no. 560" not found]

-- E --

ebuli (Hymenella) FSS no. 216 ← ["Fries"]: Fr 2: 234
eburneus (Agaricus) Fr: 33, N&B: 316, R: 37, P: 392, M: 70, SA: 575-576 ← [Bolt: 4, pl. 4, fig. 2]
eburneus (Agaricus gymnopus) Z: 91 † ← [Bolt: 4, pl. 4, fig. 2 (Agaricus ____)]
eburneus (Gymnopus) G: 610 ← [Bolt: 4, pl. 4, fig. 2 (Agaricus)]
echinatus (Agaricus) Fr: 286 ← [RC 2: 255 ← Gun 2: 125, pl. 7, fig. 6]
echinophila (Peziza) M: 23-24 ← [BH: 235, pl. 500, fig. 1]
echinus (Hydnum) Fr: 410 ← ["PCC: 26" (Hericium)]
ectypus (Agaricus) Fr: 108, sp. nov.
edule (Leccinum) G: 647 ← [BH: 322, pl. 60, 494 (Boletus)]
edulis (Agaricus) L: 473, M: 61, SA: 570-571, N&B: 322, R: 32 ← [BH: 630, pls. 137, 514]
edulis (Agaricus [Pratella]) K: 16-17 ← [BH: 630, pls. 137, 514 (Agaricus ____)]
edulis (Boletus) Fr: 392, LD 20: 181, M: 44-45, L: 470-471, SA: 553-554, K: 23-24, P: 438, N&B: 335,
    R: 22 ← [BH: 322, pls. 60, 494]
edulis (Pratella) G: 626 ← [BH: 630, pls. 137, 514 (Agaricus)]
elastica (Helvella) LD 20: 513, M: 29-30, Schl: 57, SA: 537, N&B: 346 ← [BH: 299, pl. 242]: Fr 2: 21
elasticus (Agaricus crassipes var.) P: 199 ← [With 4: 313 (Agaricus ____)]
elatinum (Hysterium) Schl: 58 ← PS: xxviii ← ["Acharius Lich. Suec. p. 22" (Opegrapha)]
elatus (Agaricus) Fr: 248 ← [BEFC 2: 11]
elegans (Agaricus) Fr: 149 ← [PS: 391]
elegans (Daedalea) Fr: 335 ← ["Sprengel V.A.H. 1820: 51"]
elegans (Thamnidium) G: 560, MNA: 507 ← [LM 3: 31]
elegans (Thelephora) Fr: 430 ← [Mey: 305]
elegans (Clavaria coralloides var.) P: 269-270, var. nov. ← [Bolt: 115, pl. 115 (Clavaria ____)]
elegans (Didymocrater) MNA: 510 ← ["Fl. Crypto. Erlangsi, p. 363"]
elephantinum (Leccinum) G: 648 ← [With 4: 412 (Boletus)]

elephantinus (Agaricus) P: 203-204, H: 20 ← [Bolt: 28, pl. 28]
elephantinus (Omphalia adusta [var.]) G: 614 ← [Bolt: 28, pl. 28 (Agaricus ____)]
eleutheratorum (Isaria) G: 563 ← ["NS 2: 23"]
elixa (Omphalia) G: 614 ← [SEF: no. 172, pl. 172 (Agaricus)]
elodes (Agaricus) Fr: 196, not 198, nom. nov.
elongata (Byssus) M: 12 ← [DC 2: 67]
elongatum (Hysterium) LD 22: 401 ← [WFL: 523]
elongatus (Agaricus mycena) Z: 102 † ← [PIC 1: 3-4, pl. 1, fig. 4 (Agaricus ____)]
elveloides (Clavaria) K: 34-35 ← ["Jacquin"]
embolus (Mucor) H: 14 † ← [With 4: 482]
emetica (Russula) G: 618 ← [Sch 4: 9 (Agaricus)]
emeticus (Agaricus) Fr: 56, Re: 53, R: 26 ← [Sch 4: 9]
emeticus (Agaricus russula) Z: 351 † ← [Sch 4: 9 (Agaricus ____)]
encephalium (Gyraria) LD 22: 306 ← ["Link"]
entomorhiza (Xylaria) G: 511 ← [Dick 1: 22 (Sphaeria)]
ephebeus (Agaricus) Fr: 238 ← ["FO 2: 187," not found]
ephemeroides (Agaricus) N&B: 319, L: 472, M: 55, SA: 565-566 ← [BH: 403, pl. 582, fig. 1]
ephemeroides (Agaricus) as "A. copr. ____" Fr: 313 ← [BH: 403, pl. 582, fig. 1]
ephemerus (Agaricus) L: 473, SA: 567, M: 57, N&B: 320 ← [BH: 394, pl. 542, fig. 1]
ephemerus (Agaricus) as "A. copr. ____" Fr: 313 ← [BH: 394, pl. 542, fig. 1]
epibryus (Agaricus) Fr: 275, not 278, sp. nov.
epichysium (Agaricus) Fr: 169 ← [PD: 25]
epidendra (Peziza) SA: 533, Schl: 58, L: 467, P: 459, M: 24, N&B: 348 ← [BH: 246, pl. 467, fig. 3]
epigaeus (Crepidopus) G: 616-617 ← [PS: 484 (Agaricus) ← POM 2: 47 (Agaricus)]
epiphylla (Isaria) M: 13 ← [PCC: 100]
epiphylla (Leotia) H: 30-31 ← [Dick 3: 22 (Clavaria)]
epiphylla (Sphaeria) Spr: 318 ← ?
epiphyllum (Dematium) H: 34, Schl: 57 ← [PS: 695]
epiphyllum (Micromphale) G: 622 ← [PS: 468 (Agaricus)]
epiphyllus (Agaricus) Fr: 139 † ← [PS: 468, in part]
epiphyllus (Agaricus) L: 474, M: 64, SA: 572 ← [BH: 543, pl. 569, fig. 2]
epiphyllus (Agaricus omphalia) Z: 346 † ← [PS: 468 (Agaricus ____)]
epipterygia (Mycena) G: 619-620 ← [Scop: 455 (Agaricus)]
epipterygius (Agaricus) Fr: 155 ← [Scop: 455]

episphaeria (Sphaeria) P: 491, in obs, Spr: 278, Schl: 59, M: 145 ← [TM 2: 21]
epixylon (Aegerita) M: 15-16 ← [BH: 90, pl. 472, fig. 1 (Reticularia)]
epixylon (Agaricus) M: 50 ← [BH: 382, pl. 581, fig. 2]
epixylon (Egerita) SA: 528-529 ← [BH: 90, pl. 472, fig. 1 (Reticularia)]
equestris (Agaricus) P: 227, H: 24 ← [LSpPl: 1642]
equina (Onygena) M: 127, G: 580 ← ["Willdenow. Berl. 412"]
equina (Peziza) G: 666 ← ["FD: pl. 779, fig. 3"]
equina (Sphaeria) G: 527, sp. nov.?
erebius (Agaricus) Fr: 246, sp. nov.
erebius (Agaricus) SB no. 582, pl. 582, fig. 2 ← [Fr: 246]
erecta (Sphaeria) P: 285-286, sp. nov.
ericaeus (Prunulus) G: 631 ← [PS: 413 (Agaricus)]
ericetorum (Agaricus) Fr: 165 ← [POM 1: 50]
ericetorum (Agaricus) M: 70 ← [BH: 523, pl. 188, pl. 523, fig. 1 "ericeus"]
ericetorum (Clavaria) Schl: 56 ← ["Schmiedel. Ic. Pl: 56; pl. 5"]
ericetorum (Micromphale) G: 622 ← [POM 1: 50 (Agaricus)]
ericeus (Agaricus) Fr: 291 ← [PS: 413]
ericeus (Agaricus) M: 66-67 ← [BH: 523, pl. 188, pl. 551, fig. 1]
ericeus (Agaricus coprinus) Z: 107 † ← [PS: 413 (Agaricus ____)]
ericosus (Agaricus pratensis [var.]) HFD 12: t. 1731, fig. 1 ← [PS: 413 (Agaricus ____)]
ericosus a flavescens (Agaricus pratensis [var.]) HFD 12 †
erinaceus (Hydnum) Fr: 407, LD 22: 95, L: 469, M: 36-37, SA: 545 ← [BH: 304, pl. 34]
eringii (Agaricus) M: 69 ← [DC 6: 47 ← Paul 2: index, cf also p. 133 "eryngii"]
ermineus (Agaricus) Fr: 22, sp. nov.
ermineus (Agaricus) SB: no. 594, pl. 594, fig. 1 ← [Fr 1: 22]
erosus (Agaricus) Fr: 145, sp. nov.
erubescens (Agaricus) Fr: 32, nom. nov.
eryngii (Agaricus) Fr: 84 ← [DC 6: 47 ← Paul 2: index, cf. also p. 133]
eryngii (Agaricus) SA: 575 ← [Paul 2: index, cf. also p. 133]
erysiphe (Sclerotium) H: 10 ← [LSpPl: 1656 (Mucor)]
erythropus (Agaricus) Fr: 122 ← [PS: 367]
erythropus (Boletus) K: 24-25 ← [POM 1: 23]
erythropus (Clavaria) G: 658 ← [PD: 38]
erythropus (Typhula) Fr: 495 ← [PD: 38 (Clavaria)]

escharioides (Agaricus) Fr: 260 ← [FO 2: 131]
eschholzii (Sphaeria) Spr: 310 ← ["EHor"]
esculenta (Helvella) K: 36, P: 453, LD 20: 513 ← [LSp: 1178 (Phallus)]
esculenta (Morchella) L: 477, M: 90, G: 661, K: 38, Schl: 58, H: 31, SA: 591, N&B: 346 ← [LSp: 1178 (Phallus)]
esculentus (Agaricus) Fr: 131 ← ["WJ 2: pl. 14, fig. 4"]
esculentus (Agaricus mycena) K: 14-15 †, Z: 103 † ← ["WJ 2: pl. 14, fig. 4"]
esenbeckii (Actidium) G: 509, nom. nov.
essequeboensis (Agaricus) Fr: 175 ← [Mey: 301]
euchrous (Agaricus) Fr: 203 ← [PS: 343]
euonymi (Erysiphe) M: 132 ← [DC 6: 105]
euphorbae cyparissiae (Hypoderma virgultorum var.) M: 152 †
evernius (Agaricus) Fr: 212, not 202 ← [FO 2: 79]
evolvens (Thelephora) Fr: 441 ← [FO 1: 154]
exaratus (Agaricus) P: 231, nom. nov.?
excelsus (Agaricus) Fr: 17, nom. nov.
excoriatus (Agaricus) Fr: 21 ← [Sch 4: 10]
excoriatus (Lepiota procera [var.])G: 601 ← [Sch 4: 10 (Agaricus ____)]
exilis (Agaricus) Fr: 206 ← [FO 2: 95]
expallens (Agaricus) Fr: 172, not 170 ← [PS: 461]
expansum (Hormiscium) LD 21: 430 ← ["Kunze. Mycet. Fasc. 1"]
expansum (Penicillium) G: 553 ← [LM 3: 17]
expansus (Merulius) SA: 558 †, sp. nov.
excissus (Agaricus) Fr: 114, sp. nov.
extinctorius (Agaricus) L: 472, M: 56, SA: 567 ← [BH: 408, pl. 437, fig. 1 ← ?LSpPl: 1643]
extinctorius (Agaricus coprinus) Z: 108 † ← [Bolt: 24, pl. 24 (Agaricus ____)]
extinctorius (Prunulus) G: 632 ← [Bolt: 24, pl. 24 (Agaricus)]

-- F --

fabarum (Corynoides) G: 654 ← ["SEF: no. 404," not found]
fagicola (Sphaeria lichenoides var.) M: 146, var. nov.?
faginea (Rubigo) G: 555 ← ["LM 3: 16," not found]
faginea (Sphaeria) Schl: 59, M: 142, H: 6 ← [PD: 3]
fagineum (Erineum) M: 16, Schl: 57 ← [POM 2: 102]
fagineum (Hydnum) Fr: 423 ← [PS: 552?]
falcata (Clavaria) Fr: 485 ← [PCC: 31, pl. 1, fig. 3]
fallax (Dermodium) G: 570 ← ["NS 2: 29"]
fallax (Hydnum) Fr: 422 ← [FNS: 39]
fallax (Sphaeria) Spr: 279 ← [PIC 2: 41, pl. 10, fig. 11]
fallax (Thelephora) Fr: 454 ← [PS: 574]
farinacea (Himantia) LD 21: 165 ← [PS: 704]
farinacea (Omphalia) G: 612 ← [Bolt: 64 (Agaricus) ← "HFA: 616"]
farinaceum (Hydnum) Fr: 419, M: 37 ← [PS: 562]
farinaceus (Agaricus) Fr: 188, not 189 ← [Sae: 365]
farinaceus (Agaricus) P: 214, H: 22 ← [Bolt: 64 ← "HFA: 616"]
farinaceus rosellus (Agaricus omphalia) Z: 348 †, nom. nov.
farinellus (Polyporus) Fr: 384, not 584, nom. nov.
farinosa (Clavaria) P: 473 ← [HBR 1: 94, with illust. (Ramaria)]
farinosa (Corynoides) G: 654 ← [HBR 1: 94, with illust. (Ramaria)]
fasciatus (Polyporus) Fr: 373 ← [SIN: 1921 (Boletus)]
fasciculare (Hydnum) Fr: 418, not 413 ← [A&S: 269, pl. 10, fig. 9]
fascicularis (Agaricus) Fr: 288, not 283, P: 196, 216, Schl: 56 ← [Bolt: 29, pl. 29]
fascicularis (Agaricus pratella) Z: 311† ← [Bolt: 29, pl. 29 (Agaricus ____)]
fascicularis (Pratella) G: 627 ← [Bolt: 29, pl. 29 (Agaricus)]
fascinans (Agaricus) Fr: 64, sp. nov.
fastibilis (Agaricus) Fr: 249 ← [PS: 326]
fastidiosa (Thelephora) Fr: 435 ← [PCC: 97]
fastigiata (Clavaria) N&B: 344, H: 29-30, SA: 540, M: 32, P: 268-269 ← [LSpPl: 1652]
favus (Boletus) M: 40 ← [BH: 363, pl. 421 ← ?LSpPl: 1645]
favus (Polyporus) Fr: index, as synonym †
felleus (Agaricus) Fr: 57, sp. nov.
felleus (Boletus) Fr: 394, SA: 554, M: 45 ← [BH: 325, pl. 379]

fenestrale (Byssocladium) G: 551 ← ["LM 7: 36"]
ferruginea (Auricularia) M: 34, P: 455-456 ← [BH: 281, pl. 378]
ferruginea (Clavaria pistillaris var.) M: 30 ← [BH: 211, not pl. 244]
ferruginea (Daedalea) Fr: 339 ← [Sae 2: 373]
ferruginea (Gyraria) G: 593 ← [BH: 281, pl. 378 (Auricularia)]
ferruginea (Nemania) G: 518 ← [POM 1: 66, pl. 5, figs. 1, 2 (Sphaeria)]
ferruginea (Peziza nigra [var.]) SA: 535, var. nov. ← [not BH: 238 †]
ferruginea (Peziza tremelloidea var.) M: 26 ← [BH: 240, pl. 410, fig. 1A]
ferruginea (Sphaeria) H: 6 ← [POM 1: 66, pl. 5, figs. 1, 2]
ferruginea (Thelephora) SA: 543, L: 468 ← [BH: 281, pl. 378 (Auricularia)]
ferruginea (Thelephora) H: 29, Schl: 60 ← [PS: 569]
ferruginea (Tremella) H: 32 ← [BH: 281, pl. 378 (Auricularia)]
ferrugineum (Hydnum) Fr: 403 ← [FO 1: 133]
ferrugineum (Stereum) G: 653 ← [PS: 569 (Thelephora)]
ferrugineus (Hypochnus) LD 22: 368 ← [PS: 569 (Thelephora)]
ferruginosus hortensis (Agaricus coprinus) Z: 112 † ← [PS: 400 †]
ferruginosus lignorum (Agaricus coprinus) Z: 112 † ← [PD: 62]
ferruginosus (Hydnum) Fr: 416 ← [PS: 562]
ferruginosus (Polyporus) Fr: 378 ← [PS: 544 (Boletus) ← ?SSp: 172]
fertilis (Agaricus) Fr: 197 ← [PS: 328]
fertilis (Gymnopus) G: 606, sp. nov. ← [not PS: 328]
fibrillosus (Agaricus) Fr: 297 ← [PS: 424]
fibrosum (Phacidium) FSS no. 162, sp. nov.?: Fr. 2: 113
fibula (Agaricus) Fr: 163, M: 67, P: 412, SA: 573-574 ← [BH: 534, pl. 186, pl. 550, fig. 1]
fibulaeformis (Hymenoscyphus) G: 673 ← [Bolt: 176, pl. 176 (Helvella)]
fibulare (Micromphale) G: 623 ← [PS: 471 ← "SOW no. 45"]
ficoides (Agaricus) R: 37, M: 69 ← [BH: 526, pl. 587, fig. 1]
ficoides (Agaricus) P: 431-432 †, in obs. ← [not BH: 526]
filiforme (Stilbum) M: 18 ← [PAB: 31, pl. 2, fig. 2 "piliforme"]
filiformis (Clavaria) M: 31, LD 21: 166, P: 272-273, SA: 539 ← [BH: 205, pl. 448, fig. 1]
filiformis (Typhula) Fr: 496 ← [BH: 205, pl. 448, fig. 1 (Clavaria)]
filopes (Agaricus) Fr: 142, N&B: 317, M: 63 ← [DC 2: 161 ← BH: pl. 320 only]
fimbriata (Daedalea) Schl: 57, sp. nov.?
fimbriatum (Hydnum) Fr: 421 ← [POM 1: 88 (Odontia)]
fimbriatum (Micromphale) G: 622 ← [Bolt: 61, pl. 61 (Agaricus)]

fimbriatus (Agaricus) Fr: 94, not 44 ← [Bolt: 61, pl. 61]
fimbriatus (Boletus) SA: 552-553, M: 44 ← [BH: 332, pl. 254]
fimbriatus (Polyporus) Fr: index only † ← [PD: 29 (Poria)]
fimetarium (Helotium) LD 20: 509, M: 19, SA: 530 ← [POM 2: 21 †]
fimicola (Agaricus) Fr: 301 † ← [PS: 412]
fimicola (Agaricus coprinus) Z: 111 † ← [PS: 412]
fimiputris (Agaricus) Fr: 300, M: 57-58, SA: 568, P: 223-224, L: 473, N&B: 321 ← [BH: 430, pl. 66]
firma (Calycina) G: 670 ← [PS: 658 (Peziza)]
fissilis (Cantharellus) Fr: 324, not 314, nom. nov.
fistulosa (Agaricus) M: 62-63, SA: 572 ← [BH: 454, pl. 518]
fistulosa (Clavaria) Fr: 479 ← [HBR: 15, with illustr.]
fistulosa (Clavaria) M: 31 ← [BH: 213, pl. 463, fig. 2]
flabellaris (Thelephora) Fr: 433 ← [BEFC 1: 227]
flabellatus (Agaricus) P: 239-240 ← [Bolt: 72, pl. 72, fig. 2]
flabelliformis (Agaricus) Fr: 185, P: 238, H: 24 ← [Sch 4: 20]
flabellus (Agaricus: "flabellaris" of index) Fr: 231, sp. nov.
flaccida (Clavaria) Fr: 471, sp. nov.
flaccidus (Agaricus) Fr: 81, P: 186-187 † ← [SEF: no. 185, pl. 185]
flammans (Agaricus) Fr: 244 ← [BEF: 87]
flammeolus (Agaricus) Fr: 71 ← [Poll: 34]
flava (Clavaria) Fr: 467 ← [Sch 4: 118, pl. 175 ← "Tourn."]
flava (Clavaria) K: 31-32 ← [Sch 4: 118]
flava (Pinuzza) G: 646 ← ["Bolt: 169," not found]
flava (Thelactis) MNA: 507, sp. nov.
flavescens (Agaricus adonis var.) M: 64, var. nov. ← [not BH: 445]
flavescens (Byssus) SA: 525, M: 11-12, L: 466 ← [DC 2: 67]
flavescens (Byssus parietina var.) M: 11, var. nov.
flavida (Spathularia) Fr: 491, G: 663, H: 30 ← [PD: 36]
flavidus (Agaricus) Fr: 250, P: 227-228 ← [Sch 4: 17]
flavidus (Boletus) Fr: 387 ← [FO 1: 110]
flavidus (Mucor) G: 560 ← [PD: 14]
flavipes (Agaricus) P: 231-232 ← [Sib: 365]
flavipes (Clavaria) Fr: 483 ← [PCC: 75]
flavipes (Agaricus mycena) Z: 101 † ← [Sib; 365 (Agaricus ____)]

flavipes (Mycena) G: 619 ← [Sib: 365 (Agaricus)]
flavo-virens (Agaricus gymnopus) Z: 99 † ← [PCS: 16 (Agaricus "flavovirens")]
flavo-virens (Nemania) G: 518 ← [Hoffm 1: 10, pl. 2, fig. 4 (Sphaeria "flavovirescens")]
flavovirens (Agaricus) Fr: 41 ← [PCS: 16]
flavus (Aspergillus) G: 555 ← [LM 3: 16]
flavus (Boletus) P: 439 ← [With 4: 415]
flavus (Cirrolus) MNA: 511, sp. nov.
flexipes (Agaricus) Fr: 212 ← [PS: 275]
flexuosus (Agaricus) Fr: 74 ← [PS: 430 (A. lactifl. ____)]
flexuosus (Lactarius) G: 624 ← [PS: 430 (A. lactifl. ____)]
flexuosus (Agaricus lactifluus) Z: 318 † ← [PS: 430]
floccopus (Boletus) Fr: 393 ← ["Vahl. Delph: 1036"]
floccosum (Hyphasma) N&B: 369, sp. nov.
floccosus (Agaricus) P: 415 ← [Sch 4: 27]
floriformis (Sphaeria) G: 530 ← [SEF: no. 297, pl. 297]
flos (Agaricus) Fr: 177 ← [Mey: 301]
flos aquae (Byssus) Fodere: 249 †
fluxilis (Agaricus) Fr: 189, sp. nov.
fodina (Byssus) M: 12 ← [DC 6: 10]
foenisecii (Agaricus) Fr: 295, not 225 ← [PIC 2: 42, pl. 11, fig. 1]
foenisecii (Prunulus) G: 631 ← [PIC 2: 42, pl. 11, fig. 1 (Agaricus)]
foetens (Agaricus) Fr: 59, not 54, R: 26 ← [POM 1: 102 (Russula)]
foetida (Thelephora puteana var.) Fr: 448 ← [Ehren: 30 (Thelephora ____)]
foetidum (Merisma) G: 654 ← [PCC: 92]
foetidus (Agaricus) Fr: 138 ← [SEF: no. 21, pl. 21 (Merulius)]
foetidus (Agaricus piperatus [var.]) SA: 562, var. nov.?
foetidus (Merulius) P: 391 ← [SEF: no. 21, pl. 21]
foetidus (Phallus) P: 470 ← [SEF: no. 21, pl. 21 (Merulius)]
foliacea (Clavaria) SA: 541, sp. nov.
foliacea (Gyraria) G: 594 ← [POM 2: 98 (Tremella)]
foliorum (Fumago) Schl: 57 ← ["P[ersoon]"]
fomentarius (Boletus) P: 244, G: 641, H: 28 ← [LSpPl: 1645]
fomentarius (Polyporus) Fr: 374 ← [LSpPl: 1645 (Boletus)]
foraminulosus (Agaricus) M: 63 ← [BH: 460, pl. 403, figs. B, C, pl. 535, fig. 1]

foraminulosus (Agaricus mycena) Z: 105 † ← [BH: 460, pl. 403, figs. B, C, Pl. 535, fig. 1 (Agaricus ____)]
formosa ([Agaricus] pseudo-aurantiacus var. amanita ____) M: 87-88 ← POM 2: 37 (Amanita muscaria var. ____)]
formosa (Clavaria) Fr: 466 ← [PIC 1: 11, pl. 3, fig. 5]
formosus (Agaricus) Fr: 208, not 206, sp. nov.
fornicatus (Pleuropus) G: 615 ← [PS: 474 (Agaricus)]
fraceolens (Hydnum) Fr: 402 ← [BrP 1: 202, pl. 82]
fragariae (Xyloma) Schl: 60, sp. nov.?
fragiformis (Peripherostoma) G: 513 ← [Dick 1: 24 (Sphaeria) ← "Scop 2: 399"]
fragiformis (Sphaeria) N&B: 296, P: 485, Schl: 59, H: 4-5 ← [Dick 1: 24 ← "Scop 2: 399"]
fragiformis (Sphaeria bicolor var.) M: 139 ← [Dick 1: 24 (Sphaeria ____) ← "Scop 2: 399"]
fragile (Hydnum) Fr: 417 ← [PS: 561]
fragile (Micromphale) G: 623 ← [LSp: 1175 (Agaricus)]
fragilis (Agaricus) Fr: 269 ← [BEFC 2: 87, pl. 39, fig. 215 ← LSp: 1175]
fragilis (Agaricus) Fr: 57 ← [PS: 440 (A. russ. ____)]
fragilis (Clavaria) Fr: 484 ← [HBR 1: 7, with illustr.]
fragilis (Rhizomorpha) M: 136, L: 485 ← [RC 1: 232 ← "Roth. Usteri's Ann. Bot. 1: 7"]
fragrans (Agaricus) Fr: 171 ← [SEF: no. 10, pl. 10 (not With.)]
fragrans (Agaricus) H: 19 ← [SEF: no. 10, pl. 10]
fragrans (Omphalia) G: 613 ← [SEF: no. 10, pl. 10 (Agaricus)]
fraxinea (Sphaeria) P: 487-488 ← [Relh: 471 ← "HFA no. 641"]
fraxineus (Boletus) M: 41-42 ← [BH: 341, pl. 433, fig. 2]
fraxineus (Polyporus) Fr: 374 ← [BH: 341, pl. 433, fig. 2 (Boletus)]
fraxini (Asteroma) SA: 517 ← [DC 6: 163-164]
fraxini (Erysiphe) Schl: 57, M: 131 ← [DC 2: 273]
fraxini (Hypoderma) M: 152-153, SA: 516, G: 509 ← [PD: 5 (Hysterium)]
fraxini (Hysterium) H: 8, Schl: 58, P: 319-320 ← [PD: 5]
frondescens (Thelephora) Fr: 436, sp. nov.
frondosa (Grifola) G: 643 ← [Dick 1: 18 (Boletus)]
frondosus (Boletus) N&B: 336, P: 440 ← [Dick 1: 18]
frondosus (Polyporus) Fr: 355 ← ["Schrank" ← Dick 1: 18 (Boletus)]
fructigena (Peziza) P: 459, M: 23 ← [BH: 236, pl. 228]
fructigenum (Oideum) ENA: 195 ← [SMH: 80]
fructigenus (Hymenoscyphus) G: 673 ← [BH: 236, pl. 228 (Peziza)]
frumentaceus (Agaricus) Fr: 46, M: 77 ← [BH: 602, pl. 571, fig. 1]

frustulata (Thelephora) Fr: 445, Schl: 60 ← [PS: 577]
frustulosa (Auricularia) M: 34 ← [PS: 577 (Thelephora "frustulata")]
fucatus (Agaricus) Fr: 40, sp. nov.
fugax (Cytispora) FSS no. 211, sp. nov.: Fr 2: 544
fugax (Merulius) Fr: 328 ← [FO 1: 100]
fulgens (Agaricus) Fr: 216 † ← [PC: 10]
fuliginea (Clavaria pistillaris var.) M: 30, nom. nov. ← [BH: 211, polynomial]
fuligineo-album (Hydnum) Fr: 400, "fuligineoalbum" of index ← [SMH: 88, "fuligineo-album"]
fuligineus (Albatrellus) G: 645 ← [PS: 516 (Boletus)]
fuligineus (Merulius hydrolips var.) M: 48 ← [PS: 490, (Merulius ____)]
fuligeneus (Polyporus) Fr: 348 ← [PS: 516 (Boletus)]
fuliginosa (Auricularia reflexa var.) M: 34 ← [BH: 282, pl. 483, fig. 2 "fuliginea"]
fuliginosa (Elvella) LD 20: 513 ← [Sch 4: 113, t. 320]
fuliginosa (Helvella) H: 31, P: 256-257 ← [Sch 4: 113 (Elvella)]
fuliginosa (Nemania) G: 517, sp. nov.?
fuliginosa (Thelephora) Schl: 60, sp. nov.
fuliginosa (Torula) Schl: 60 ← ["P[ersoon]"]
fuliginosum (Dematium) Schl: 57 ← ["Ach[arius]"]
fuliginosus (Agaricus) Fr: 73 ← ["Fries" ← "Krapf. t. 4, figs. 5-7"]
fuliginosus (Boletus) Schl: 56 ← ["Schr[ader]"]
fulva (Helvella mitra [var.]) SA: 537 ← [BH: 298 †, pl. 466]
fulva (Helvella mitra var.) M: 29 ← [BH: 298 †, pl. 466]
fulva (Merulius undulatus var.) M: 48 ← [BH: 293, pl. 465, figs. 1A, D, E (Helvella crispa var. ____)]
fulva (Peziza scutellata var.) P: 460 ← [Relh: 466 ← "HFA no. 636"]
fulvum (Polystigma) SA: 516, M: 151 ← ["Persoon in Mougeot & Nestler. Vog. Crypt. no. 271"]
fulvus (Agaricus) Fr: 37, SA: 579, M: 76 ← [BH: 608, pl. 555, fig. 2, pl. 574, fig. 1]
fulvus (Agaricus pectinaceus var.) M: 52, var. nov. ← [not BH: 599]
fulvus (Agaricus pectinatus [var.]) SA: 562, var. nov. ← [not BH: 599]
fulvus (Agaricus pyxidatus var.) M: 68, var. nov. ← [not BH: 514]
fulvus (Boletus) Fodere: 249, sp. nov.?
fumosa (Clavaria) Fr: 483 ← [POM 1: 31-32]
fumosus (Agaricus) Fr: 88 ← [PS: 348]
fumosus (Hypochnus) LD 22: 368 ← [FO 2: 279-280]
fumosus (Polyporus) Fr: 367 ← [PS: 530 (Boletus)]
fungorum (Dematium herbarum) Schl: 57 ← [PS: 699 (D. herbarum [var.] ____)]

fungorum (Sclerotium) SA: 617 ← ["De Candolle. Mem. Mus. 2: 414"]
furcata (Clavaria) Fr: 486, nom. nov.
furcatus (Agaricus) R: 26 ← [POM 1: 102 ← "Gmelin. Syst. Nat. Linn. II: 1410"]
furcatus (Agaricus) Fr: 59 ← ["Lamarck. Encycl. p. 106" (Amanita)]
furfuraceus (Agaricus) Fr: 262 ← [PS: 454]
furfuraceus (Agaricus) M: 78 ← [BH: 621, pl. 532, fig. 1]
furfuraceus (Ascobolus) H: 33 ← [POM 1: 33]
fusca (Auricularia cariophyllea var.) M: 33 ← [BH: 284, pl. 278 (A. "caryophyllea" var. ____)]
fusca (Auricularia reflexa var.) M: 34 ← [BH: 282, pl. 483, fig. 2]
fusca (Auricularia tremelloides var.) M: 34 ← [BH: 278, pl. 290]
fusca (Clavaria coriacea var.) M: 33, var. nov.?
fusca (Daedalea) Fr: 339 ← ["Link"]
fusca (Helvella elastica var.) M: 29-30 ← [BH: 299, pl. 242, fig. C]
fusca (Helvella mitra [var.]) SA: 537 ← [BH: 298, pl. 190, figs. D, E, pl. 466, fig. E]
fusca (Helvella mitra var.) M: 29 ← [BH: 298, pl. 190, figs. D, E, pl. 466, fig. E]
fusca (Merulius undulatus var.) M: 48 ← [BH: 293, pl. 465, figs. B, C (Helvella crispa var. ____)]
fusca (Morchella esculenta var.) M: 90 ← [BH: 274, pl. 218, figs. E, F, H (Phallus esculentus var. ____)]
fusca (Peziza) M: 19 ← [POM 1: 29]
fusca (Peziza labellum var.) M: 25 ← [BH: 262, pl. 204]
fusca (Peziza stipitata var.) M: 24 ← [BH: 271, pl. 196, figs. A, B, C]
fusca (Sphaeria) N&B: 296, M: 139, L: 486, G: 529, H: 5, Schl: 59 ← [PAB: 22, pl. 2, fig. 3]
fusca (Thelephora) Fr: 451 ← [POM 1: 38 †]
fuscescens (Dasyscyphus) G: 671 ← [PS: 654 (Peziza)]
fusco-atrum (Hydnum) Fr: 416 ← [FNS 1: 39]
fusco-purpureus (Agaricus) Fr: 128, "fuscopurpureus" of index ← [PIC 1: 12, pl. 4, fig. 1]
fusco-violaceum (Hydnum) Fr: 421 ← [Ehren: 30 (Sistotrema)]
fuscum (Peripherostoma) G: 513 ← [PAB: 22, pl. 2, fig. 3 (Sphaeria)]
fuscum (Sporotrichum) G: 551 ← [LM: 12]
fuscus (Hypochnus) Schl: 58 ← [FO 2: 280]
fusiformis (Agaricus) M: 71, sp. nov. ← [BH: 612 †]
fusiformis (Clavaria) Fr: 480, P: 476, G: 657 ← [SEF: no. 234, pl. 234]
fusipes (Agaricus) Fr: 120, N&B: 313, SA: 578-579, M: 71 ← [BH: 612, pl. 516, fig. 2, pl. 106]
fusipes (Gymnopus) G: 604-605 ← [BH: 612, pl. 516, fig. 2, pl. 106 (Agaricus)]

-- G --

galeatum (Helotium) LD 20: 507 ← ["Holmskjold. Coryphaei p. 25"]
galeopsidis (Erysiphe) M: 134 ← [DC 6: 108]
galericulata (Mycena) G: 619 ← [Scop: 455 (Agaricus)]
galericulatus (Agaricus) P: 413 ← [Scop: 455]
galericulatus (Agaricus mycena) Z: 100 † ← [Scop: 455 (Agaricus ____)]
galii (Hypoderma virgultorum var.) M: 152, var. nov.?
geicola (Sphaeria lichenoides var.) M: 146, var. nov.?
gelatinosa (Helvella) SA: 538, P: 259-260, M: 30 ← [BH: 296, pl. 473, fig. 2]
gelatinosa (Peziza) M: 26 ← [BH: 239, pl. 460, fig. 2]
gelatinosum (Hydnum) LD 22: 95 ← [Scop: 472]
gelatinosum (Steccherinum) G: 651 ← [Scop: 472 (Hydnum)]
gentianae (Erysiphe) Schl: 57, sp. nov.?
geophilus (Agaricus) M: 80 ← [BH: 546, pl. 522, fig. 2]
geophyllus (Agaricus) P: 406 ← [BH: 546, pl. 522, fig. 2 "geophilus"]
georgii (Agaricus) P: 409, H: 21 ← [LSpPl: 1642]
geotropicus (Agaricus) SA: 575 ← [BH: 521, not pl. 573, pl. 400 "geotropius"]
geotropus (Agaricus) M: 69, N&B: 315 ← [BH: 521, pl. 573, fig. 2 "geotropius"]
gibba (Omphalia) G: 612 ← [PS: 449 (Agaricus)]
gibbosa (Daedalea) P: 248-249 ← [POM 1: 21 (Merulius)]
gibbosa (Dothydea) Schl: 57 ← [FOM 2: 349 "gibberulosa" ← "Acharius. sec. spec."]
gigantea (Byssus) M: 12, not 11, SA: 525 ← [TM 1: 36 (Xylostroma)]
giganteum (Xylostroma) P: 508, G: 559 ← [TM 1: 36]
giganteus (Agaricus) P: 400 ← [Sch 4: 37]
gilva (Omphalia) G: 612 ← [PS: 448-449 (Agaricus)]
gilvus (Agaricus omphalia) Z: 348 † ← [PS: 448-449 (Agaricus ____)]
glabra (Agaricus ephemeroides var.) M: 55, var. nov. ← [not BH: 403-404]
glabrum (Geoglossum) LD 18: 357, Schl: 57, G: 658 ← ["PCC: 36"]
glabrum (Helotium) LD 20: 509 ← [TM 1: 22, pl. 4, fig. 35]
glandulosa (Tremella) M: 28, SA: 536, L: 235 ← [BH: 220, pl. 420, fig. 1]: Fr 2: 224
glandulosus (Agaricus) M: 51 ← [BH: 388, pl. 426]
glauca (Monilia) N&B: 367, SA: 526-527, M: 14, H: 33-34 ← [LSP: 1186 (Mucor)]
glaucopa (Cortinaria) G: 629 ← [Sch 4: 23 (Agaricus)]
glaucopus (Agaricus araneosus var.) M: 82, SA: 583, P: 204-205 ← [Sch 4: 23 (Agaricus ____)]

glaucum (Coremium) G: 563 ← [LSP: 1186 (Mucor)]
glaucus (Agaricus) M: 72 ← [BH: 593, pl. 521, fig. 1]
glaucus (Aspergillus) G: 553 ← [LSP: 1186 (Mucor)]
glaucus (Mucor) P: 502 ← [LSP: 1186]
glechomae (Sphaeria) Schl: 59, sp. nov.?
gleditschii (Poronia) G: 515 ← [Willd: 400]
globifera (Cytispora) FSS no. 212 ← ["Fries. V.A.H. 1818: 119" (Bostrychia)]: Fr 2: 546
globosum (Hysterium) LD: 22: 400, Schl: 58 ← [PS: 98]
globulare (Sclerotium) M: 130 ← [DC 2: 278]
glomerata (Sphaeria) Schl: 59 ← ["Ach[arius]"]
glomerulosa (Botrytis) M: 15, SA: 528 ← [BH: 101, pl. 504, fig. 3 (Mucor)]
glomerulata (Sphaeria) SA: 521, M: 140, LD 22: 386 ← [BH: 178, pl. 468, fig. 3 (Hypoxylon)]
glutinosus (Agaricus) SA: 582 ← [BH: 527, pl. 587, fig. 2; pl. 539, pl. 258]
glutinosus ([Agaricus]) M: 81 ← [BH: 527, pl. 587, fig. 2; pl. 539, pl. 258]
gnaphaliocephalus (Agaricus) M: 69-70 ← [BH: 517, pl. 576, fig. 1]
gnomon (Sphaeria) P: 280 ← [TM 2: 50, pl. 16, fig. 125]
gossypinus (Agaricus) M: 56 ← [BH: 419, pl. 425, fig. 2]
gracile (Hysterium) Spr: 310 ← ["Ehor"]
gracilis (Agaricus fistulosus var.) M: 63, var. nov. ← [not BH: 454]
gracilis (Agaricus pratella) Z: 308 † ← [PS: 425 (Agaricus ____)]
gracilis (Clavaria) G: 656, P: 268 ← [Bolt: 111, pl. 111, fig. 1]
gracilis (Prunulus) G: 630-631 ← [PS: 425 (Agaricus)]
graminaria (Sphaeria punctiformis var.) M: 146, var. nov.: Fr: 2: 525
graminis (Erysiphe) M: 133 ← [DC 6: 106]
graminis (Nemania) G: 516 ← [POM 1: 18 (Sphaeria)]
graminia (Peziza) Schl: 58, sp. nov.?
graminis (Sphaeria) N&B: 299, M: 141, Schl: 59 ← [POM 1: 18]
grammocephalus (Agaricus) M: 76 ← [BH: 616, pl. 594]
grammopodius (Agaricus) N&B: 313, M: 71-72 ← [BH: 617, pl. 548, pl. 585, fig. 1]
graniformis (Sphaeria) Schl: 59, sp. nov.?
granulata (Tubercularia) G: 547, M: 129 ← [PS: 113]
granulosa (Lepiota) G: 602 ← [BEF: 79]
granulosa (Peziza) M: 22 ← [BH: 258, pl. 438, fig. 3 "granulata"]
granulosa (Sphaeria) SA: 521, P: 493, M: 139 ← [BH: 176, pl. 487, fig. 2 (Hypoxylon)]
granulosum (Peripherostoma) G: 514 ← [BH: 176, pl. 487, fig. 2 (Hypoxylon)]

granulosus (Agaricus croceus var.) P: 197-198 ← [BEF: 79 (Agaricus ____)]
granulosus (Mucor) P: 503 † ← [BH: 109, pl. 504, fig. 13]
graphicum (Hypoderma) LD 22: 371 ← [FOM 1: 194 (Hysterium)]
graveolens (Agaricus) R: 37, P: 206-207 ← [PS: 361]
graveolens (Gymnopus) G: 609-610 ← [PS: 361 (Agaricus)]
grisea (Ascophora) G: 561 ← [PD: 14 (Mucedo)]
grisea (Clavaria) N&B: 344 ← [PCC: 44]
grisea (Haplaria) LD 20: 273, G: 552 ← [LM: 11]
grisea (Helvella mitra [var.]) SA: 537, nom. nov.
grisea (Himantia) LD 21: 164 ← [FOM 1: 211]
griseum (Fusidium) G: 544 ← [LM: 8]
griseum (Tuber) N&B: 351 ← [PS: 127-128]
grossa (Clavaria) Schl: 56, N&B: 345 ← ["POM 2: 50," not found]
grysea (Peziza papillosa var.) M: 22, var. nov.
guttaeforme (Astoma) G: 524 ← [SEF: no. 393, pl. 393, fig. 5 "gutta"]
gyrans (Clavaria) LD 21: 166, M: 30, P: 471 ← [BEFC 1: 235, fig. 164]

MYCOTAXON

Vol. III, No. 2, pp. 261-273 January-March 1976

BOLETES OF THE SOUTHWESTERN UNITED STATES

HARRY D. THIERS

Department of Biology
San Francisco State University
San Francisco, California 94132

SUMMARY

Results of three summer collecting seasons in the southwestern United States are presented. Descriptions of the following previously undescribed species of boletes are included: Boletus barrowsii, Leccinum subalpinum, Suillus kaibabensis, Suillus occidentalis and Suillus wasatchicus. A total of fifty-five species of these fungi have now been recorded from this area.

During the summers of 1970, 1971 and 1972 collecting expeditions were made to the southwestern states with considerable amounts of time spent in southwestern Colorado, northern and western New Mexico, the Uintas Mountains in eastern Utah and northern and western Arizona. The specific purpose was to explore the bolete flora of these regions; however, all fleshy fungi were collected as time permitted. During June and early July the flora was extremely limited, but during late July and August, perhaps as a result of increased thunderstorm activity, there was a marked increase in the variety and number of basidiocarps. Two areas were particularly impressive: the aspen forests of southern Colorado and the Kaibab Plateau in northern Arizona. Both areas supported an abundant flora of boletes, particularly Leccinum and Suillus species, as well as other Homobasidiomycetes. The New Mexico and Utah areas, although not as productive during the time spent there, undoubtedly have a significant and interesting flora of fleshy fungi.

Data from these explorations, supplemented by herbarium records and earlier reports in the literature, indicate that Boletus is represented by twenty species, Suillus by eighteen, Leccinum by twelve, Tylopilus by three, and both

Gyroporus and Fuscoboletinus by one each. None of the areas within the southwest has been extensively studied and all warrant further study. Particularly exciting would be an opportunity to study the flora of the forested peaks of southern Arizona and New Mexico because of their isolation from other forested areas.

The data, although obviously incomplete, indicate a rather close affinity with the fleshy fungus flora of the west coast. No rough-spored species, for example, have been found in either area. Furthermore, there is a much greater duplication of species between this region and the west coast than with those on the east coast or midwest. Some eastern species, however, such as Boletus affinis, B. luridus, Suillus subaureus and Tylopilus alboater, do extend into New Mexico, but are not known from more westerly regions. There is much duplication in the floristic composition of the forests of the southwest and far west which is probably the most important factor influencing the similarity of the fungus flora of the two regions.

In the following descriptions of new species all colors in quotes are from Ridgway (1912). Collections are on deposit in the Cryptogamic Herbarium of San Francisco State University (SFSU). Grateful acknowledgement is made to the National Science Foundation for Grants Nos. 2932 and 2932A which financed much of the field work.

Boletus barrowsii Thiers & Smith sp. nov.

Pileus 9-20 cm latus, convexus demum late convexus vel plano-convexus, siccus, tomentosus vel velutinus, albidus vel pallide subroseo-bubalinus, immutabilis. Contextus 2-3 cm crassus, albus, immutabilis. Sapor odorque mites. Tubuli 1-2 cm longi, subflavi vel isabellini; pori 1-2 mm lati, immutabiles. Stipes 8-15 cm longus, 2-5 cm crassus, reticulatus, clavatus, immutabilis, siccus, pileo concolorus. Sporae 13-15 x 4-5 µm, subcylindricae vel anguste subfusoideae. Cystidia 37-50 x 5-9 um, fusoideo-ventricosa. Hyphae cuticulae appressae vel intertextae. Holotypus (Thiers 27816) lectus prope Jacob Lake, Kaibab National Forest, Coconino County, Arizona, Aug. 21, 1971; in herbario San Francisco State University (SFSU) conservatus.

Pileus (6) 9-10 (30) cm broad when mature, convex to pulvinate when young becoming broadly convex to plano-convex with age; surface dry, dull, smooth, sometimes obscurely rimose, when young often covered with a fine pruinose coating that is easily removed, or appearing glabrous, sometimes becoming tomentose to velutinous with age, or remaining glabrous, white to whitish or buff ("cartridge buff" to "pale pinkish buff" to "pinkish buff") during all stages of development, unchanging or becoming brown when bruised; margin incurved, entire. Context 2-3 cm thick, floccose, white except sometimes pale vinaceous near the cuticle, unchanging when exposed; taste mild, odor mild or sometimes strong and unpleasant when dried.

Tubes 1-2 cm long, depressed, white when young, becoming yellow ("colonial buff" to "deep colonial buff" to as dark as "Isabella color") with age; pores 1-2 mm, angular, stuffed when young, concolorous with the tubes, unchanging or darkening slightly when bruised.

Stipe 8-15 cm long, 2-5 cm broad at the apex, bulb up to 9 cm broad, equal to clavate to bulbous at the base, sometimes with a narrowed point at the base; solid; surface dry, whitish to pinkish buff or pinkish cinnamon, white at the base, unchanging when bruised, reticulate, often all the way to the base, reticulations typically fine and delicate. Context white, unchanging when exposed.

Spores 13-15 x 4-5 µm, subfusoid to subellipsoid in face view, inequilateral in profile, smooth, thin-walled, pale ochraceous in KOH and Melzer's reagent; basidia clavate, 4-spored, hyaline in KOH, 25-34 x 8-11 µm; hymenial cystidia crowded on the pores, scattered to numerous on the sides, hyaline in KOH, thin-walled, cylindric to subclavate to obscurely fusoid-ventricose, 37-50 x 5-9 µm; tube trama strongly divergent from a poorly defined central strand, hyaline in KOH, hyphae 3-5 µm broad; pileus trama homogeneous, interwoven, hyphae 2-4 µm broad; cuticle poorly differentiated as a cutis of appressed to slightly interwoven hyphae, hyphae 4-6 µm broad, hyaline, not gelatinous. No clamp connections seen.

Spore deposit dark olive brown.

Chemical Reactions. HNO_3 - cuticle orange, context yellow. $FeSO_4$ - context gray.

Habit, habitat and distribution. Gregarious to solitary in soil under conifers. It is typically found under ponderosa pine (*Pinus ponderosa* Dougl. ex P. & C. Lawson) but firs (*Abies* sp.) have sometimes been observed in the immediate vicinity. In New Mexico it has also been found in mixed populations of conifers and hardwoods, particularly oaks. At present *Boletus barrowsii* is known from New Mexico and Arizona in the southwestern United States and from Idaho in the northwestern region. It has also been found in Mexico.

Material studied. Arizona: Thiers 27739, 27816 - holotype, 27817, 27818, 27819, 28110, 28176, 28185, 28279, 28969. Idaho: Miller 9, 9a, Trueblood 2220. New Mexico: Barrows 922, 1348. Mexico: Guzman 3013.

Observations. The white tubes that are "stuffed" when young and which later become yellow plus the reticulate stipe place this species in the section *Boletus*, Subsection *Boleti* with *Boletus edulis*, *B. aereus* and other well known species. The white to pallid color of the pileus and stipe readily distinguishes it from other species within that section. Other characteristics which distinguish it are the somewhat narrow spores, the absence of any amyloid reaction in the hymenium and the poorly developed cuticle. Its edibility is unknown.

This species is named in honor of Charles Barrows of Sante Fe, New Mexico, who first brought it to our attention.

Leccinum subalpinum sp. nov.

Pileus 8-20 cm latus, globosus vel convexus demum plano-convexus vel planus vel depressus, siccus demum viscidus, tomentosus vel appresso-fibrillosus demum fibrilloso-squamosus, russus vel lateriticius vel rufobrunneus. Contextus albus tarde fuscus. Sapor et odor mites. Tubuli 1-2.5 cm longi, pallide olivaceo-bubalini, tactu avellanei. Stipes 6-15 cm longus, 1-3 cm crassus, siccus, albus; squamae parvae, albae aetate nigrae. Sporae 13.5-15.5 x 4-5 µm, ellipsoideae vel subellipsoideae. Cystidia 28-35 x 8-13 µm. Cuticula intertexta. Holotypus (Thiers 26823) lectus prope Bald Mountain Pass, Uintas Mountains, Wasatch National Forest, Summit County, Utah, Aug. 7, 1970; in herbario San Francisco State University (SFSU) conservatus.

Pileus (5) 8-20 cm broad, globose to convex when young becoming pulvinate to plano-convex to plane to slightly depressed on the disc with age; surface dry to subviscid when young becoming viscid with age, conspicuously tomentose to appressed fibrillose when young, typically becoming strongly appressed-fibrillose scaly with age, usually scales more strongly developed toward the margin, tips of scales sometimes breaking free with age, remaining strongly apparent in dried basidiocarps; surface more or less evenly colored dark reddish brown ("morocco red" to "burnt sienna" to "mahogany red" to "bay") when young, often with areas irregularly distributed which are red ("grenadine red" to "flame scarlet"), unchanging or becoming dark reddish brown to reddish orange ("Kaiser brown" to "Hays russet" to "Mars orange" to "English red") with age, unchanging when bruised; margin usually with a conspicuous sterile flap. Context white, unchanging or very slowly and erratically changing directly to fuscous with no reddish intermediate phase; taste and odor mild.

Tubes 1-2.5 cm long, adnexed to deeply depressed, pallid ("pale olive buff"), staining pale vinaceous ("avellaneous") when exposed or bruised; pores small, up to 1 mm broad, angular, concolorous with the tubes, staining brown when bruised.

Stipe 6-15 cm long, 1-3 cm broad at apex, equal to subclavate to clavate, not bulbous, occasionally ventricose; solid; surface dry, background white or occasionally pale umber or gray, scabrosities typically pallid when young becoming very dark brown or black with age, sometimes remaining inconspicuous. Context white, unchanging or slowly becoming fuscous, rarely with a slightly reddish intermediate phase in basal portion, occasionally becoming blue in the base.

Spores 13.5-15.5 x 4-5 µm, pale ochraceous in KOH, ochraceous in Melzer's reagent, ellipsoid to subcylindric in face view, ventricose in profile, smooth, thin-walled; basidia 18-22 x 7-9 µm, hyaline, clavate, 4-spored; hymenial cystidia rare to scattered, obscure, hyaline, clavate, 28-35 x 8-13 µm; tube trama obscurely divergent, hyaline, subgelatinous, hyphae 7-9 µm broad; pileus trama interwoven, homogeneous, hyphae 4-6 µm broad; pileus cuticle differentiated as a tangled trichodermium, cells elongated, no short or inflated cells, little or no disarticulation, walls smooth, contents pale yellow-orange in KOH, bright ochraceous tawny in Melzer's reagent, pigment globules developing in Melzer's reagent, hyphae 5-6 µm broad. No clamp connections seen.

Chemical Reactions. $FeSO_4$ - context gray. Guaiac - positive.

Habit, habitat and distribution. Scattered to gregarious in soil under lodgepole pine and Engelmann spruce. It has been collected only at altitudes between 6,000 and 8,000 feet and has been found only in Utah and Arizona.

Material studied. Arizona: Thiers 27269. Utah: Thiers 26778, 26823 - holotype, 26824, 26825, 26826.

Observations. When first seen this species was somewhat suggestive of _Leccinum_ _fallax_ because of its stature and similarly colored pileus. There are, however, several differences between the two species. The most important of these is that the pileus of _L_. _subalpinum_ is either conspicuously tomentose or fibrillose to fibrillose-scaly, whereas that of _L_. _fallax_ appears fibrillose only when viewed under a lens. In addition, the cap of _L_. _fallax_ remains orange red when dried, the stipe is strongly clavate and the scales on the stipe surface never blacken, whereas in _L_. _subalpinum_ the basidiocarps are dull reddish brown when dried, the stipe is not clavate-bulbous and the scales on the stipe typically become black with age.

Suillus _kaibabensis_ sp. nov.

Pileus 3-8 cm latus, convexus demum plano-convexus vel depressus, glaber, viscidus, bubalinus vel subroseo-bubalinus interdum luteus vel ochraceo-bubalinus, immutabilis, margine glabro. Contextus 1-1.5 cm crassus, albus vel flavus, immutabilis. Sapor et odor mites. Tubuli 3-5 mm longi, ochraceo-bubalini vel lutei, immutabiles; pori 1-3 mm lati. Stipes 2-4 cm longus, 4-15 mm crassus, siccus, albidus, ad basim flavus, glandulosus, sine velo. Sporae 8-9 x 3-3.5 µm, ellipsoideae vel subcylindricae. Cystidia fusca in KOH et Melzer's. Cuticula intertexta, viscida. Holotypus (Thiers 27813) lectus prope Jacob Lake, Kaibab National Forest, Coconino County, Arizona, Aug. 21, 1971; in herbario San Francisco State University (SFSU) conservatus.

Pileus 3-8 cm broad, convex to plano-convex to depressed on the disc with a slightly elevated margin, often somewhat undulating on the margin; surface smooth, viscid, even, glabrous, buff to light brown ("warm buff" to "ochraceous buff" to "pinkish cinnamon" to occasionally as dark as "cinnamon") when older, sometimes more yellow ("light greenish yellow" to "pale greenish yellow"), unchanging or darkening slightly when bruised; margin incurved becoming decurved, entire, no evidence of a false veil. Context 1-1.5 cm thick, typically white except yellow to yellowish directly above the tubes, unchanging when exposed or bruised; taste and odor not distinctive.

Tubes 3-5 mm in length, depressed to subdecurrent, buff ("ochraceous buff" to "colonial buff") to yellow ("antimony yellow" to "chamois") during all stages of development, unchanging when bruised; pores 1-3 per mm, angular, concolorous or frequently dark salmon ("ochraceous salmon"), unchanging when bruised, often with scattered droplets of liquid when young.

Stipe 2-4 cm long, 1-2 cm broad at the apex, equal or tapering slightly toward the apex; solid; surface dry, typically white to pale yellow when young in the apical region and pale vinaceous ("avellaneous") toward the base, becoming darker yellow in the apex with age, unchanging in the base, noticeably glandulose, at least in upper portion, sometimes becoming inconspicuously so toward the base; glandulae reddish brown, small, but sometimes large and elongated to irregular in outline; no partial veil. Context yellow, unchanging.

Spores pale yellow to hyaline in KOH, ochraceous in Melzer's reagent, ellipsoid to subcylindric, walls thin, smooth, 7.6-9.5 x 3.2-4.5 µm; basidia 4-spored, clavate to cylindric, hyaline in KOH, yellow in Melzer's reagent, 21-26 x 6-7 µm; hymenial cystidia clustered, clavate, dark orange brown in KOH, slightly darker in Melzer's reagent, 38-72 x 6-11 µm; tube trama strongly divergent, hyaline in KOH, yellow in Melzer's reagent, subgelatinous; pileus trama homogeneous, hyaline except ochraceous near cuticle; pileus cuticle an ixotrichodermium, hyaline in KOH, hyphae 2-4 µm broad; stipe cuticle subgelatinous to gelatinous, interwoven, with numerous fascicles of caulocystidia similar to the hymenial cystidia. Clamp connections absent.

Chemical Reactions. KOH - context vinaceous. $FeSO_4$ - context gray.

Habit, habitat and distribution. Scattered to gregarious in soil under ponderosa pine (Pinus ponderosa). Basidiocarps often occurring in large numbers during August, and sometimes forming fairy rings. Commonly found in National Forest Campgrounds, for example, the Jacob Lake Campground in northern Arizona where considerable soil compaction had occurred. Known only from the Kaibab National Forest in Arizona at elevations of 6,000 to 8,000 feet.

Material studied. Arizona: Thiers 27623, 27673, 27678, 27776, 27813 - holotype, 27905, 28035, 28184, 28295, 29572, 29749, 29780, 29784, 29787.

Observations. This species belongs to the section Suillus. It is distinguished by the pallid, glabrous pileus, the absence of a veil or false veil, the short tubes and the strong development of the glandulae on the stipe. S. occidentalis with which it might be confused lacks noticeable glands on the surface of the stipe. The reddish to pink pores of S. wasatchicus distinguish it from S. kaibabensis. The pallid color of the pileus and the absence of a false veil separate S. kaibabensis from S. granulatus and S. albidipes.

Suillus occidentalis sp. nov.

Pileus 6-10 cm latus, convexus demum late convexus vel plano-convexus, glaber, viscidus, ochraceo-bubalinus, margine glabro. Contextus albus, ad marginem flavus, immutabilis. Sapor et odor mites. Tubuli 0.5-1 cm longi, flavi, immutabiles; pori 1-2 mm lati. Stipes 2-4 cm longus, 1-2 cm crassus, siccus, albus vel flavus; glandulis inconspicuis, sine velo. Sporae 8-9 x 3-4 µm, ellipsoideae vel subcylindricae. Cystidia fasciculata, fusca in KOH. Cuticula intertexta, viscida. Holotypus (Thiers 27775) lectus prope Point Sublime, North Rim, Grand Canyon National Park, Coconino County, Arizona, Aug. 19, 1971; in herbario San Francisco State University (SFSU) conservatus.

Pileus 6-10 cm broad when mature, convex when young, becoming broadly convex to plano-convex to highly irregular in outline with age, margin sometimes uplifted and often rimose in older pilei; surface viscid, gluten often unevenly distributed causing surface to appear scaly, no trace of fibrils or fibrillose scales, glabrous, but sometimes becoming rimose-scaly with age, buff to light brown ("light ochraceous buff" to "ochraceous buff"), sometimes pinkish brown ("light pinkish cinnamon") on the disc, unchanging when bruised; margin incurved, entire, glabrous, no evidence of false or partial veil fragments. Context 1-2 cm thick, white when young becoming yellow, at least on the margin, when older, unchanging when exposed; taste and odor mild.

Tubes 0.5-1 cm long, subdecurrent to shallowly depressed, when young tan to yellow ("warm buff" to "antimony yellow") to occasionally near yellow ("pinnard yellow") on the margin with age typically becoming dark yellow to orange yellow ("pale yellow orange" to "light orange yellow" to "buff yellow" to apricot yellow"), unchanging when bruised; pores 1-2 mm, angular, concolorous with the tubes.

Stipe 2-4 cm long, 1-2 cm broad at apex, equal to tapering slightly toward the base or apex; solid; surface dry, white to yellow ("baryta yellow") at the apex becoming pale yellow ("ivory yellow") toward the base; glandulae obscure and often not apparent to the naked eye, never becoming conspicuous, but becoming more noticeable after handling. Context yellow in the cortex, whitish toward the center, unchanging when exposed.

Spores 8-9.6 x 3-4 µm, ellipsoid to subfusoid to subcylindric, hyaline to pale ochraceous in KOH and Melzer's reagent, walls thin, smooth; basidia hyaline in

KOH, 4-spored, 19-23 x 6-8 µm; hymenial cystidia fascicled, clavate, dark brown in KOH, dark orange-brown in Melzer's reagent, 40-50 x 8-10 µm; tube trama divergent, hyaline in KOH; pileus trama homogeneous, interwoven, hyaline in KOH except dark brown under cuticle; pileus cuticle an ixotrichodermium, hyaline in KOH; caulocystidia similar to the hymenial cystidia. Clamp connections absent.

Chemical Reactions. NH_4OH - context rose-red. KOH - context rose-red to vinaceous. $FeSO_4$ - context gray.

Habit, habitat and distribution. Scattered to gregarious in soil under ponderosa pine (*Pinus ponderosa*). This *Suillus* is known only from the Kaibab National Forest of Arizona where it occurs at elevations varying from 6,000 to 8,000 feet.

Material Studied. Arizona: Thiers 27622, 27650, 27655, 27661, 27674, 27775 - holotype, 27880, 28149, 28175, 28294.

Observations. This species belongs to the Section *Suillus*. It is distinguished by the obscure glands on the surface of the stipe, the absence of a veil, the pallid color of the pileus and the white stipe. The glandulae on the stipe are either absent or poorly developed suggesting a possible relationship with *S. subaureus* which has, however, a tomentose or fibrillose cuticle, or with *S. brevipes* which has a short stipe and a much darker colored pileus. In addition neither of these species is known to form mycorrhizal associations with ponderosa pine.

Suillus wasatchicus sp. nov.

Pileus 5.5-6.5 cm latus, convexus demum planus vel plano-convexus, viscidus, glaber, subflavus vel flavus, margine glabro. Contextus 1-1.5 cm crassus, subflavidus, immutabilis. Sapor mitis; odor pungens. Tubuli 0.5-1 cm longi, flavi, immutabiles; pori minus quam 1 mm lati, glandulis testaceis. Stipes 3-5 cm longus, 1.5-2 cm crassus, tubulis concolorus apice, ad basim albus, siccus, glandulosus, sine velo. Sporae 8-10.4 x 3-4.5 µm, ellipsoideae vel subcylindricae. Cystidia fasciculata.

Cuticula intertexta, viscida. Holotypus (Thiers 25618) lectus prope Yellow Pines Campground, Uintas Mountains, Wasatch National Forest, Summit County, Utah, June 21, 1970; in herbario San Francisco State University (SFSU) conservatus.

Pileus 5.5-6.5 cm broad, convex when young becoming plane to plano-convex, sometimes undulate on the margin; surface viscid but not glutinous, shining when moist, dull when dry, glabrous, yellow ("primuline yellow" to "antimony yellow" to "yellow ocher") during all stages of development, occasionally with pinkish or reddish flushes but never developing reddish blotches or scales as in S. americanus or S. sibiricus; margin entire, incurved; no evidence of a false or partial veil. Context 1-1.5 cm thick, very pale yellow throughout, unchanging when exposed; taste mild, odor rather strong and pungent.

Tubes 0.5-1 cm long, decurrent when young becoming somewhat depressed with age, dark yellow ("mustard yellow" to "wax yellow"), unchanging when bruised or exposed; pores less than 1 mm broad, angular, densely covered with reddish to testaceous glandulae causing the pores to appear dark pink to red when young, usually becoming yellow with age, unchanging when bruised.

Stipe 3-5 cm long, 1.5-2 cm broad at the apex, equal except somewhat attenuated or pinched at the base; solid; surface concolorous with the tubes in apical portion becoming white or whitish toward the base, dry, covered with conspicuous glandulae over the entire surface; glandulae reddish when young, darkening with age. Context very pale yellow, unchanging when exposed.

Spores 8-10.4 x 3-4.5 µm, pale ochraceous in KOH, ochraceous in Melzer's reagent, ellipsoid to subfusoid to subcylindric, slightly inequilateral in profile, walls thin, smooth; basidia 4-spored, hyaline in KOH, contents granular in KOH, 20-25 x 7-9 µm; hymenial cystidia rare to absent on sides of tubes, crowded to abundant on pores, fascicled, no solitary cystidia seen, basal portion of cystidial cluster staining brown in KOH and Melzer's reagent, individual cystidia clavate to cylindric, thin-walled, 27-35 x 7-10 µm; caulocystidia similar to hymenial cystidia; tube trama hyaline in KOH, strongly divergent from a poorly defined central strand, hyphae 4-7 µm broad, no laticiferous hyphae; pileus trama loosely interwoven, hyphae 4-5 µm in diam., pale brown in KOH; pileus cuticle differentiated as an ixotrichodermium, 250-350 µm thick, hyphae closely interwoven, hyphae 2-4 µm in diam., hyaline in KOH; hypodermis narrow, compactly interwoven, brown in KOH. Clamp connections absent.

Chemical Reactions. Unknown.

Habit, habitat and distribution. Scattered to solitary in rocky soil under ponderosa pine (*Pinus ponderosa*). Known only from the type locality in the Uintas Mountains of eastern Utah.

Material studied. Utah: Thiers 25439, 25618 - holotype.

Observations. *S. wasatchicus* seems to be related to the *S. granulatus* - *S. albidipes* complex but these species have a dark brown pileus. The reddish to pink discoloration of the pores of *S. wasatchicus* due to the accumulation of glandulae is highly distinctive. The absence of any type of fibrillose covering on the surface of the pileus readily distinguishes this species from *S. hirtellus*. *Suillus flavoluteus* can easily be distinguished by the purplish-red color of the basal portion of the stipe.

The following species of boletes are now known from the southwestern United States.

Boletus affinis
Boletus amylosporus
Boletus barrowsii
Boletus bicolor
Boletus calopus
Boletus chrysenteron
Boletus edulis
Boletus erythropus
Boletus fragrans
Boletus luridus
Boletus piperatus
Boletus porosporus
Boletus pulverulentus
Boletus rubripes
Boletus subglabripes
Boletus subtomentosus
Boletus subvelutipes
Boletus truncatus
Boletus vermiculosis
Fuscoboletinus aeruginascens
Gyroporus castaneus
Leccinum atrostipitatum
Leccinum aurantiacum
Leccinum brunneum
Leccinum cinnamomeum
Leccinum discolor
Leccinum fallax
Leccinum incarnatum
Leccinum insigne var. *insigne*
Leccinum insigne var. *brunneum*

Leccinum insigne
  var. *insigne*
  f. *ochraceum*
Leccinum subalpinum
Leccinum vulpinum
Suillus albidipes
Suillus americanus
Suillus brevipes
Suillus brunnescens
Suillus flavogranulatus
Suillus glandulosipes
Suillus granulatus
Suillus kaibabensis
Suillus lakei
Suillus luteus
Suillus occidentalis
Suillus pseudobrevipes
Suillus sibiricus
Suillus subaureus
Suillus tomentosus
Suillus umbonatus
Suillus wasatchicus
Tylopilus alboater
Tylopilus ferrugineus
Tylopilus porphyrosporus

Literature Cited

Overholts, L. O., 1919. Some Colorado Fungi. Mycologia 11: 245-258

Ridgway, R. 1912. Color Standards and Color Nomenclature. Pub. by Author. Washington, D. C.

Seaver, F. J. & P. F. Shope. 1936. Some Rocky Mountain Basidiomycetes. Univ. Colo. Studies 23: 189-197.

Smith, A. H. & H. D. Thiers. 1964. A Contr. toward a Monograph of North American Species of *Suillus*. Pub. by Authors. Ann Arbor, Mich.

MYCOTAXON

Vol. III, No. 2, p. 274 January-March 1976

NOTICE

MYCOTAXON POLICY ON ARGUMENTS SUPPORTING PROPOSALS ON NOMINA GENERICA CONSERVANDA

Supporting statements and arguments in support of proposals for the conservation of generic names have, until recently, been published in full in the journal TAXON, the official journal of the International Association for Plant Taxonomy.

In the interests of conserving space, the Editors of that journal have determined that henceforth only ten-line summaries of such arguments will be published there, with xerox copies of the original type scripts available upon request (Taxon 24(4): 534. 1975).

Authors of proposals for conserved generic names for fungi and lichens should still process their proposals through the International Association for Plant Taxonomy so that they will come to the attention of the appropriate Special Committees for consideration. It is the belief of the Editors of MYCOTAXON, however, that the arguments which may be raised often have application beyond the specific case in point. We open the pages of this journal to full documentation and discussion of any such proposal for conservation of names of genera of fungi or lichens.

MYCOTAXON

Vol. III, No. 2, pp. 275-296 January-March 1976

SPECIES OF LYCOPERDON WITH A SETOSE EXOPERIDIUM

V. DEMOULIN (*)

Département de Botanique, Université de Liège,
Sart Tilman, B-4000 Liège, Belgique.

SUMMARY

Three species of *Lycoperdon*, two of them new, with a setose exoperidium are described. Their taxonomic position is discussed and a key to *Lycoperdon* with unusual spherocysts in their peridium is provided.

RESUME

Trois espèces de *Lycoperdon*, dont deux nouvelles, à exopéridium formé de sétas sont décrites. Leur position taxonomique est discutée et un clé pour la détermination des *Lycoperdon* pourvus de sphérocystes inhabituels dans le péridium est fournie.

First described by Kreisel and Dring (1967) in *Morganella velutina* (Berk. et Curt.) Kreisel et Dring, an exoperidium whose exostratum is composed of spherocysts transformed into setae was also found by Kreisel (1967) in *Bovista ochrotricha* Kreisel. In the course of my monographic revision of the genus *Lycoperdon*, I have now observed such an exoperidium in three species of this genus, while in several others some of the spherocysts show a tendency toward a setose type. Such an anatomy seems, therefore, not to be exceptional among the Lycoperdaceae, especially in tropical regions.

Observations of peridial structures were made on preparations boiled in chloral hydrate. Melzer's reagent was

---

(*) Chargé de recherches du F.N.R.S.

used to detect a dextrinoid (pseudoamyloid) reaction. Spores and capillitium were observed in lactophenol-cotton blue after a short boiling. Spore measurements are based on 10 spores per fruitbody; the values given are the extremes and the extreme means. For capillitium and spherocysts only maxima are recorded. The term spherocyst is used to designate all inflated more or less individualised elements of the exoperidium, whatever their exact shape. The letters A,B,C,D refering to spores indicate increasingly strong warts (A spores punctate, D almost spiny).

I am much obliged to the curators of several herbaria cited in the text (abbreviations according to the Index herbariorum) for the loan of material and to H. Kreisel and I.P.S. Thind for the loan or gift of interesting personal collections. The Royal Botanical Gardens in Kew, the New York Botanical Garden and the National Fungus Collection at the USDA Center Beltsville are institutions which have been especially helpful. I thank D.M. Dring and J.T. Palmer for critical reading of my manuscript.

LYCOPERDON ATRUM PAT.,

Bull. Soc. Mycol. France XVIII (2) : 176 (1902)

Syn. : *L. juruense* P. Henn., Hedwigia 43 : 184 (1904).

Fig. 1a; 2a,b; 3-5.

Fruitbodies subglobose, turbinate or pyriform, 1-4,5 cm high, 1,2-3,5 cm broad. Subgleba cream to yellowish brown, subcompact, small (0,2 mm) locules being only locally visible, transition to the gleba gradual. Exoperidium a dense coating of warts or small spines or even a continuous velvety layer near the base of the fruitbody. Colour from yellowish brown to blackish, always darker at the top of the fruitbody. Exoperidium (exostratum) at top of fruitbody made up of thick walled setae (up to 85 x 12 μ, wall 4,0 μ) mixed with more isodiametric but also thick walled and usually irregularly shaped elements (Fig. 2a). In some fruitbodies, near the base, when the exoperidium is velvety, the setae are dominant and up to 220 x 28 μ, wall 4,0 μ (Fig. 2b). In other fruitbodies caducous tips are present continuing the warts in spines made up of elements variable in shape (from hyphae to pure spherocysts) but always thin walled (Fig. 4). Those spines of thin walled spherocysts may be restricted to the base of the fruitbody or totally lacking. In the darkest specimens, setae of the top contain

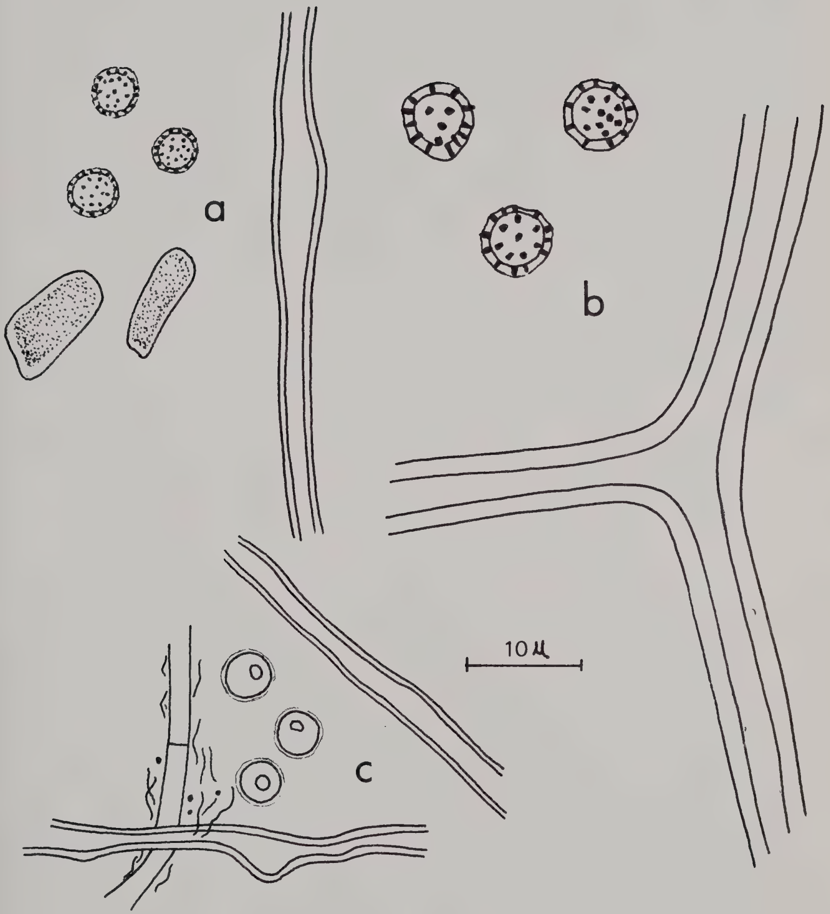


Fig. 1. a. Spores, capillitium and persistent basidia (?) of *Lycoperdon atrum* (Isotype of *L. juruense*, Ule, Herb. Bras. 2707, HBG). b. Spores and capillitium of *L. setiferum* (Thind 10092, LG). c. Spores, capillitium and paracapillitium of *L. melanesicum* (Lauterbach 56h, WRSL). All drawings 1500 x.

a dark brown pigment usually maintained in chloral hydrate, even without fixation. Some setae may be slightly dextrinoid. Endoperidium only accidentally visible,e.g. when plates of exoperidium excoriate as happens in some specimens, cream to yellowish, dull, frequently with raised lobes at the pore margin. Endoperidial hyphae dextrinoid,the most strongly so at the subgleba level, weakly or not cyanophilous, with little septation and swelling (up to 10 μ) at the pore level, the formation of the pore being mostly due to a loosening of the hyphae which may even be entirely lacking. Gleba a light purplish brown tending toward greyish lilacine, with pseudocolumella little distinct. Capillitium elastic, seldom septate, fairly branched, occasionally nodular, broadness variable up to 2,8-8,4 μ, with moderately thick, yellowish brown wall up to 0,6-1,2 μ, devoid of pores. Paracapillitium lacking or poorly developed. Spores 3,2-3,4-4,6-5,2 μ, moderately (C) but densely verrucose, with a density of 10-16 warts for 10 μ of circumference. The highest wart density (14-16) occurs on the small spores (less than 4 μ). Broken pedicels, badly preserved, and oblong bodies (e.g. 9 x 5 or up to 16 x 6 μ) with cyanophilous content, which seem to be persistent basidia, mixed to the spores (Fig. 1a, 5).

Observations : 1. If one compares the specimens from Bradenton and the collection from Cuba or the isotypes of *Lycoperdon juruense* (two collections very similar) one gets the impression they belong to two distinct species. In the Bradenton collections, spines (caducous on top of the fruitbody) up to 0,5 mm, made up of thin walled elements, continue the warts made of setae, the colour is at most dark brown and the spores are 3,6-4,2-4,6-4,9 μ. In the two other collections spines of thin walled elements are totally lacking and the warts themselves are thinner but denser and pass to a continuous velvety cover on the subgleba,the top of the fruitbody is almost black and the spores are 3,2-3,4-3,65-3,8 μ . In this case however it seems that the dimension of spores is not a significant taxonomic character. These two collections are the only ones with spores

Fig. 2. a. Setae on top of the fruitbody of *Lycoperdon atrum* (Isotype of *L. juruense*, Ule, Herb. Bras. 2707, HBG). b. id. near base of the fruitbody. c. Setae of *L. setiferum* (Thind 10092, LG). d. Setae of *L. melanesicum* (Lauterbach 56 h, WRSL). All drawings 750 x.

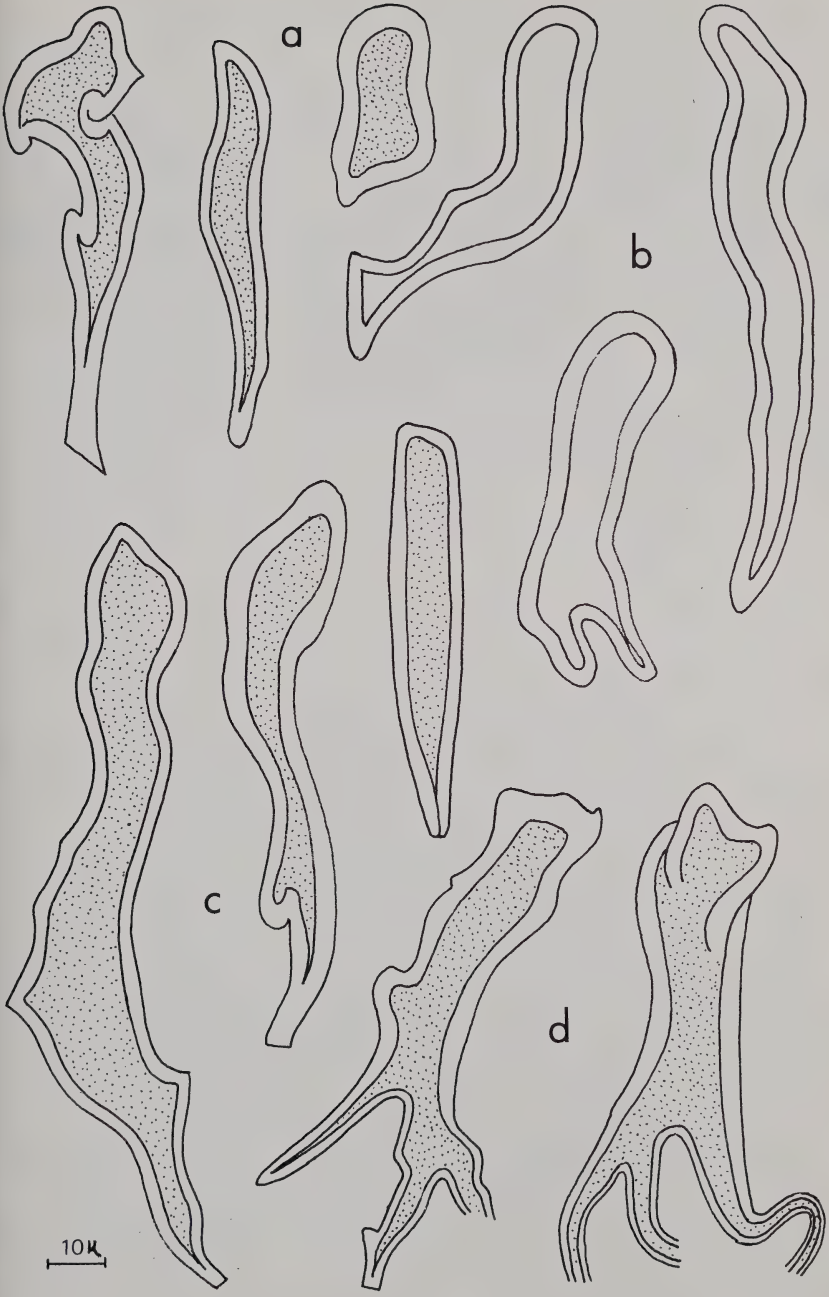


Fig. 2

smaller than 4 μ, while the material distributed by Rick, which has a very similar exoperidium, has spores of the larger type. The mean of all spore diameters measured in collections with small spores (5 fruitbodies, 10 spores per fruitbody) is 3,5 μ. For collections with large spores (23 fruitbodies) it is 4,4 μ. The corresponding spore volumes would be approximately 22,5 and 44,6 μm^3 or almost exactly the double for large spores. Further the mean wart density is 12 for a circumference reduced to 10 μ in large spores and 15 in small spores. As the ratio 12/15 = 0,800 is almost equal to the one of the mean spore diameter 3,5/4,4 = 0,795, one must conclude that wart density is inversely proportional to spore diameter. The general conclusion is that one must be dealing with a species having forms with a simple and a double nuclear number per spore as have been studied by Gross and Schmitt (1974). As long as these spore sizes are not correlated with other characters, I do not consider these small and large spore variants worthy of taxonomic recognition.

The difference in exoperidial aspect could be more important, but the second Florida collection is already much poorer in thin-walled spherocysts, while the Uruguayan material, though still retaining a few caducous spines, is even more intermediate between those collections and the rest of the material. It may be that more collecting would disclose that some differences are constant enough to necessitate splitting the species as here understood (for example the Florida collection, or the Florida collection and the Uruguay ones on one side), but, given the large plasticity of exoperidial characters in response to environmental effects (see, for example, Calonge and Demoulin, 1975), I would not expect it.

2. The presence of capillitium distinguishes this species from *Morganella*, whilst the anatomy of the exoperidium, the subcompact subgleba and the total lack of pores in the capillitium separate it from *L. molle* Pers. per Pers. and related species.

3. The type of *L. atrum* was lost in the post when returned by Dennis who had borrowed it from FH. An extensive description has however been made by this author and

Fig. 3. *Lycoperdon atrum*, dark extremely setose form (Isotype of *L. juruense*, Ule, Herb. Bras. 2707, HBG). x 1,2.

Fig. 4. *Lycoperdon atrum*, pale form with a few spines (Florida, Cocoanut Grove,by Peacock River,Thaxter,NY). x 2,5.

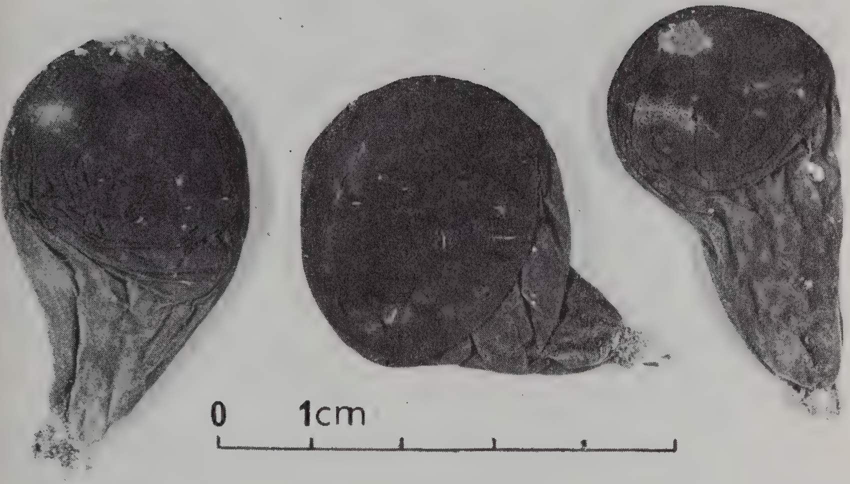


Fig.3

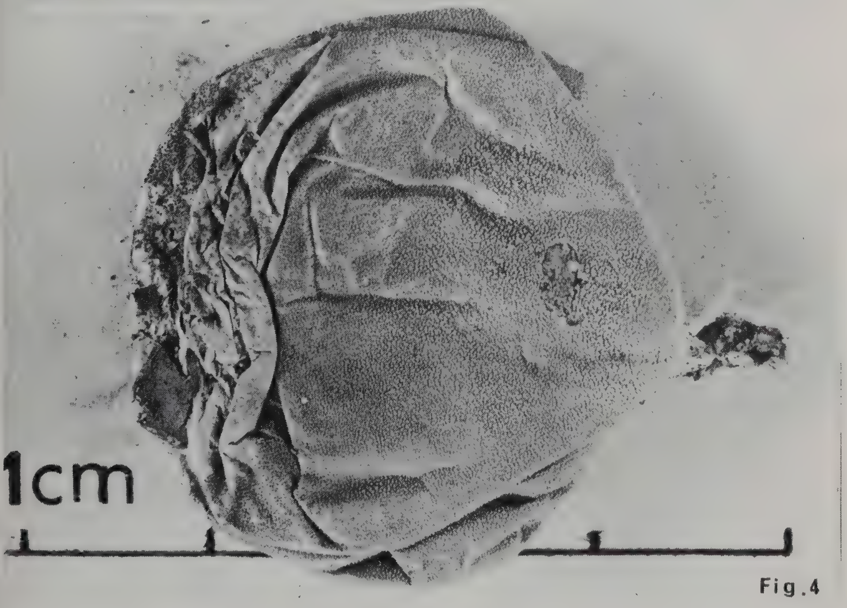


Fig.4

SEE ERRATA

deposited in FH (partly published in Dennis, 1953) allowing an unambiguous interpretation of the taxon. One point only is obviously inaccurate in Dennis description : the mention of reticulated spores, which would be quite unexpected in a *Lycoperdon*. Given the very dense warts, I have ascertained it is not difficult when not using the best mounting media and optics to mistake the space between warts for a raised reticulum. The setae were recorded by Dennis in his manuscript notes but not in the published description.

Material studied :

- Brasil : Estado de Amazonas, im Wald v. Juruá Miry, 8/1901, E. Ule, Herbarium Brasiliense 2707 (HBG, isotype of *L. juruense*, should be considered lectotype following the destruction of Hennings's herbarium. A duplicate of the same collection is in FH). São Leopoldo, 1907, Rick, Fungi Austro-Americani 214. Distributed under the name of *L. juruense* which is correct but antedated by *L. atrum*. The collection at HBG was studied in detail. Other parts seen are in BPI, COI, NY, PAD.

- Cuba : Prov. of Oriente, Ensenada de Mora, on dead wood, 26-29/3/1912, N.L. Britton, J.F. Cowell and J.A. Shafee 13000 (NY).

- Martinique, no date, P. Duss, notes on type of *L. atrum* in FH (cf. obs. 3).

- Uruguay : Dep. de Canelones, Floresta, silv. cupress. ad vias aren.,20/6/1948 and 6/1949, W.G. Herter 50248 and 50847 (BPI).

- U.S.A. : Florida, 315, 16th str., Bradenton, Manatee Co., 17/9/1946, 26/6/1947, 12/1948, early July 1949, 16/10/1952, C.B. Stifler (FLAS, F47911, 47913, 47907, 47895, 47886). F47886 is given as growing under Carissa. Florida, Cocoanut Grave, by Peacock River, no date, R. Thaxter (NY). Two collections.

Fig. 5. *Lycoperdon atrum*, spores, capillitium and persistent basidia (?) (Florida,Cocoanut Grove,by Peacock River, Thaxter, NY). x 1500.

Fig. 6. *Lycoperdon setiferum*,spores, capillitium and broken pedicels (holotype, Murree, Ahmad, K). x 1500.

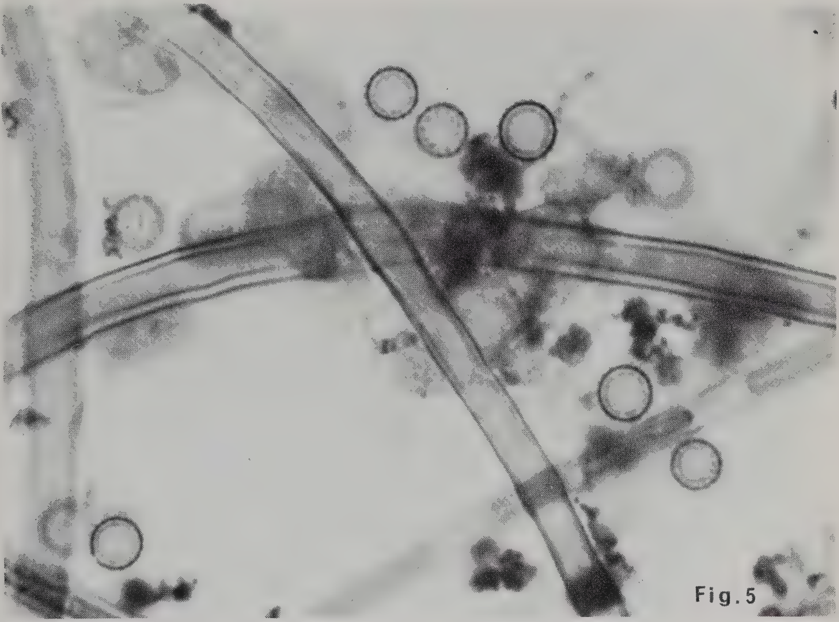


Fig. 5

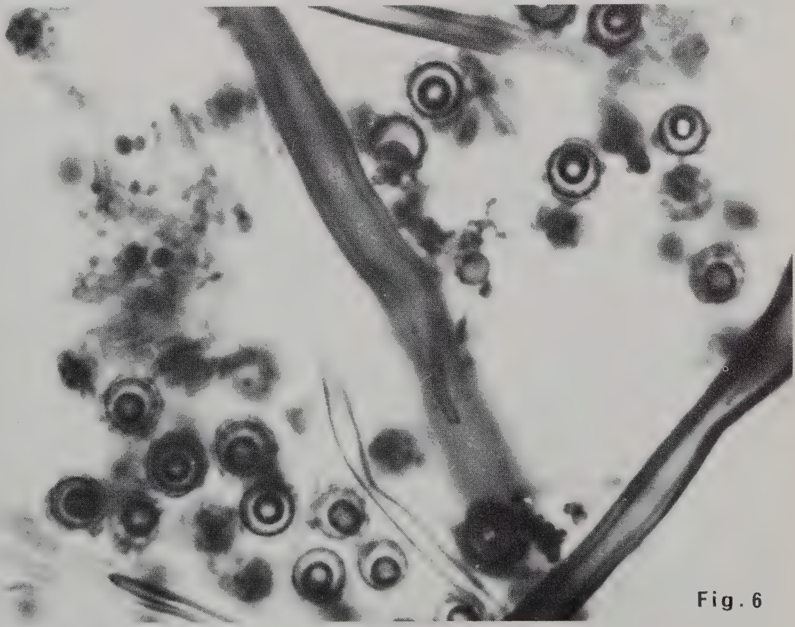


Fig. 6

LYCOPERDON SETIFERUM DEMOULIN, sp. nov.

Fig. 1b, 2c, 6, 7.

Carposomata subglobosa usque turbinata, 2-5 cm diam., verrucis angulatis vel aculeis imperfectis luteo-brunneis usque nigricantibus dense obtecta. Gleba purpuraceo-brunnea. Subgleba bene evoluta. Exoperidium ex setis (ex. 130 x 16 µ, paries 2,6 µ) pigmentum brunneum continentibus praecipue compositum. Capillitium usque 4,8-8,0 µ latum, elasticum, brunneum, sine septis, pariete crasso (usque 0,9-1,8 µ), poris absentibus vel rarissimis. Sporae magnae, 4,0-4,5-4,8-5,2 µ, verrucis altis (D), sparsis (7-9 cum 10 µ circ.), reliquiis sterigmatorum intermixtae. Alteris *Lycoperdonibus* cum setoso exoperidio distinctum sporis valde verrucosis et *L. atropurpureo*, *L. mauryano* et *L. delicato* exoperidii setis distinctum.
Holotypus : Pakistan, Murree, 8/1948, S. Ahmad (K).

Fruitbodies subglobose to turbinate, 2-5 cm in diam. Subgleba cream to lilacine, with rather well formed locules, up to 1 mm. Exoperidium a dense coating of angular warts or ill defined convergent spines, from yellowish brown to blackish, darker on top of the fruitbody. Beside some regular spherocysts and more or less isodiametric elements of contorted shape, those warts are dominated by seta-like, thick walled, spherocysts, about a hundred µ in length (e.g. 130 x 16 µ, wall 2,6 µ) (fig. 2c). At least on top of the fruitbody they hold a dark brown pigment usually maintained in chloral hydrate, even without fixation. Near the base of the fruitbody there is much less intracellular pigment and one can sometime find tips of spines made up of thin-walled spherocysts (up to 35 µ in diam.). Endoperidium only accidentally visible, cream to yellowish, slightly shiny, sometimes with raised lobes at the margin of the pore. Endoperidial hyphae dextrinoid but only some of them cyanophilous (gleba level), with some septation and swelling (up to 15 µ) at the pore level. Gleba purplish brown, with a not very well developed pseudocolumella. Capillitium elastic, aseptate, fairly well branched, up to 4,8-8,0 µ broad, with a thick brown wall, up to 0,9-1,8 µ, devoid of

Fig. 7. *Lycoperdon setiferum* (holotype, Murree, Ahmad, K). x 2,25. Courtesy of the Royal Botanic Gardens, Kew (negative n° 14683).

Fig. 8. *Lycoperdon melanesicum* (holotype, Degener 15547a, NY). x 6.

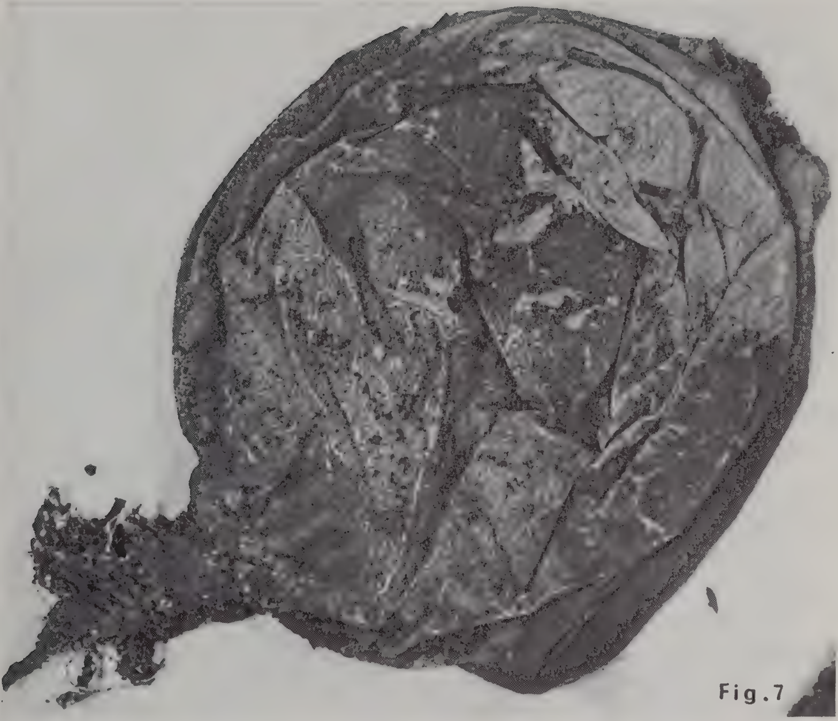


Fig.7

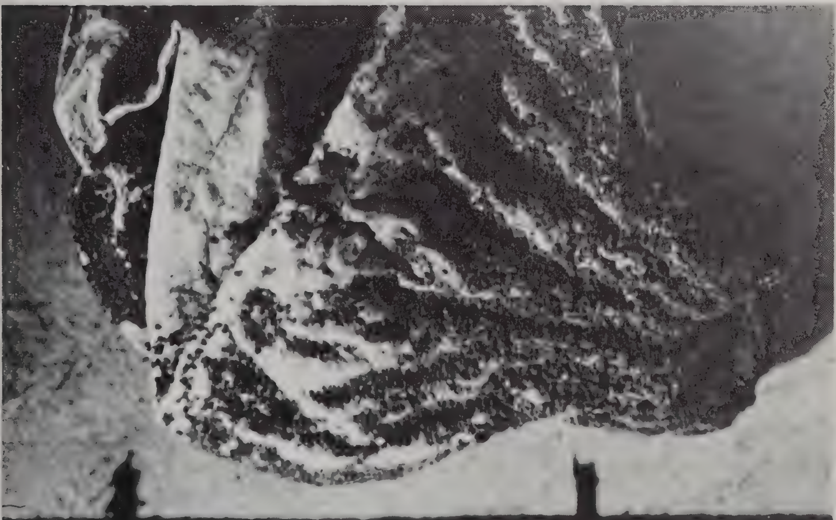


Fig.8

SEE ERRATA

pores or these very rare, small and of irregular outline, restricted to some of the thinner walled hyphae. Paracapillitium lacking. Spores 4,0-4,5-4,8-5,2 μ in diam., with very strong (D) sparse warts (density 10-16 for 10 μ of circumference). Ectospore frequently conspicuous. Well preserved broken pedicels abundantly mixed with the spores (fig. 1b, 6).

Observations : 1. This species is liable to be confused with *L. delicatum* Berk., which occurs in the same area. The diagnostic characters are the setae of the exoperidium and the spores with higher, sparser warts (10-12 for 10 μ of circumference in *L. delicatum*). Macroscopically the exoperidium presents better defined spines in *L. delicatum*. The heavily verrucose spores separate this species from all other *Lycoperdon* spp. with setoid elements in the exoperidium. *L. atropurpureum* Vitt., from southern Europe and the mediterranean basin, and *L. mauryanum* Demoulin, from America, have similar spores but lack a setose exoperidium.

2. I have studied a collection from Japan which apparently belongs to this species, Chiba, 10/1906, M. Gono in h. C.G. Lloyd, cat. 23330 (BPI) (n° in my notes, 474). However, since it is made up of two specimens only, I prefer to wait for further collecting to decide upon its identity.

Material studied :

- unlocalised : SW Himalayas, no date, Falconer (K) (note n° 415).

- India : Sat tal, Nainital (U.P.), coniferous forest, 17/8/1973, I.P.S. Thind 10201 (PAN) (note n° 651). Jagat Sukh, Kulu, H.P., 25/9/1971, I.P.S. Thind 10092 (dupl.) (LG).

- Pakistan : Murree, 8/1948, S. Ahmad (K) (note n° 412) (holotype). Ibid., 25/9/1953, S. Ahmad 15721 (K and dupl. in pers. herb. H. Kreisel) (note n° 414). Patriata, Murree Hills, 9/1953, no collect. (K) (note n° 416).

SEE ERRATA [illegible]

LYCOPERDON MELANESICUM DEMOULIN, sp. nov.

Fig. 1c, 2d, 8-10.

Carposomata subglobosa, 1,3-2 cm diam., rhizomorphis albis praedita. Gleba brunnea. Subgleba aut absens aut minima et albida. Exoperidium velutinum vel granulosum, brunneum, setis (ex. 100 x 10 µ, paries 2,6 µ) in base ramosis et pigmentum brunneum continentibus compositum. Capillitium usque 2,9-3,7 µ latum, elasticum (luteo-) brunneum, pariete haud valde crassa (usque 0,6-1,0 µ), sine septis et poris. Paracapillitium praesens. Sporae minutae, 3,3-3,7-3,8-4,0 µ, leves. *L. pyriformi* proximum, sed subgleba parum evoluta et exoperidio insignite setoso distinctum. Holotypus : Fiji, Viti Levu, Ra, 17/6/1941, O. Degener 15547a (NY).

Fruitbodies subglobose, 1,3-2 cm in diam. White rhizomorphs well developed. Subgleba white, reduced to a swelling of the endoperidium or seldom with a few small (0,2 mm) ill-defined locules. Exoperidium a dense velvety to granular deep brown coating (Fig. 8) of rather irregularly shaped, thick-called setae up to 100 µ in length (e.g. 100 x 20 µ, wall 7 µ) with a slightly yellowish, dextrinoid wall and brown contents, and a branching, root like base (Fig. 2d, 10). Endoperidium only accidentally visible, cream, dull, rather thick, made up of generative (septate and thin-walled) and sclerified (thick walled e.g. 1,4 µ for a diam. of 3,3 µ,aseptate) hyphae, dextrinoid but not (or occasionally the contents) cyanophilous. Gleba brown. Pseudocolumella lacking. Capillitium elastic, aseptate, little branched, but somewhat nodulose, up to 2,9-3,7 µ, with brown (on the yellowish side) wall up to 0,6-1,0 µ, devoid of pores. Paracapillitium abundant, but thin (2,4-3,0 µ) and not very well preserved. Capillitium and paracapillitium incrusted by debris from glebal membranes and pedicels and cyanophilous globules. Spores 3,3-3,7-3,8-4,0 µ in diam., appearing smooth in usual mounting media (Fig. 1c, 9).

Observations : 1. This species might be mistaken for a *Morganella* [especially *M. samoensis* (Bres. et Pat.) Ponce de Leon] from which it differs in the presence of capillitium. Glebal membranes are also more disorganised than usual in that genus. The other possible confusion is with *Lycoperdon pyriforme* Schaeff. per Pers., whose subgleba is better developed and distinctly chambered and whose exoperidium is made up of spherocysts which, while of irregular, often spiny outline, are often more or less isodiametric and not more than 50 μ long. The Lauterbach and Troggatt collections were, in fact, filed under *L. pyriforme*.

2. The lack of a well developed, chambered subgleba would exclude this species from the genus *Lycoperdon* as emended by Kreisel (1964). It is, however, so obviously related to *L. pyriforme* with spores, capillitium and anatomy of the endoperidium almost identical, and an exoperidium, although different, closely related with irregular, thick-walled, dextrinoid spherocysts, I cannot place it in a distinct genus.

Material studied :

- Wald bei Butaneny, Novo-Guinea, 3/5/1890, Lauterbach 56 h (WRSL).

- Solomon Islands, growing on dry trunk of Coconut, 20/7/1909, W.W. Troggatt in h. C.G. Lloyd, cat. 54488 (BPI).

- Fiji, Viti Levu, Ra, vicinity of Rewasa near Vaileka, alt. 50-200 m, Vatundamu, on log on dry forested forehill, 28/5-17/6/1941, O. Degener 15547a (NY) (holotype).

Taxonomic position of *Lycoperdon* with setose exoperidium

Exoperidial characters are those one is most tempted to use in the taxonomy of *Lycoperdaceae* because they are quite easily observed. Aspects observed with the unaided eye or a good lens are usually correlated with microscopical anatomy, the observation of which does not require the excellent optic necessary to study spore ornamentation or capillitial pits. Caution must, however, be exercised when using those characters, for they seem strongly influenced

Fig. 9. *Lycoperdon melanesicum* (holotype, Degener 15547a, NY). Spores, capillitium and paracapillitium. x 1500.

Fig. 10. *Lycoperdon melanesicum* (holotype, Degener 15547a, NY). Setae. x 300. Melzer reagent.

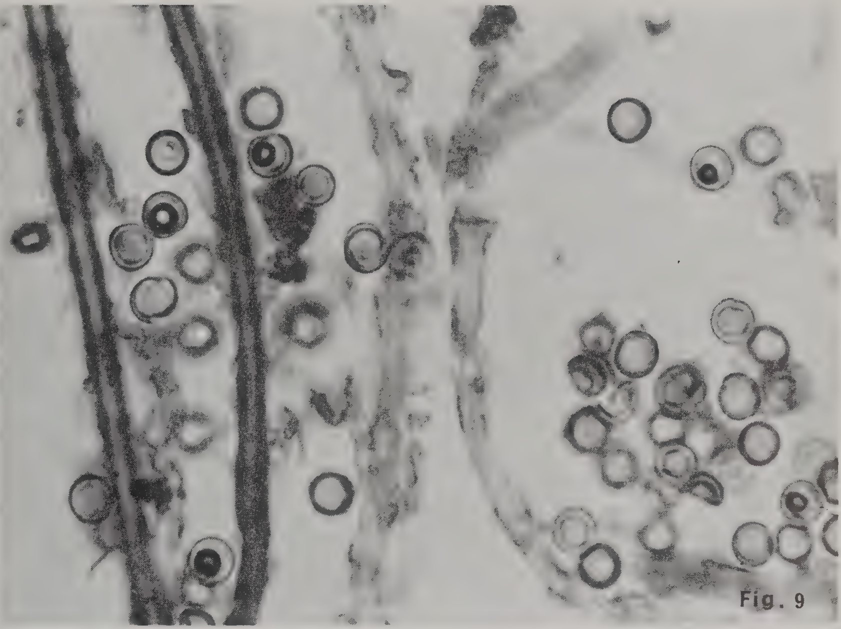


Fig. 9

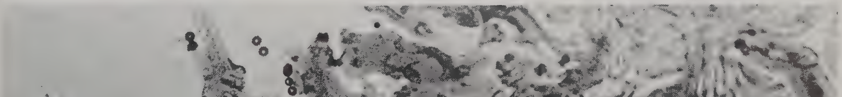


Fig.10

by ecology. In some species, a given character may be under direct environmental control and such an ecophenic variation must be taken into account when delimiting species. The same character may be constant in other species but those will usually prove to be of a restricted ecology and the character should not be used in sectional classification.

This is especially true of colour and size of the spines : on average, *Lycoperdaceae* of wet areas have darker, longer spines than those of dry regions. A species of oceanic affinity like *Lycoperdon foetidum* always has long dark spines, while *L. marginatum*, of dry continental open areas, always has short white spines. A species with broad ecology and distribution like *L. perlatum* varies from whitish to blackish and two sides of a single fruitbody may even be quite different.

Nonetheless when correlated with other characters, especially structure of the endoperidium, spores and capillitium, some trends in exoperidial anatomy may be considered of phylogenetic significance. While I do not want to place a judgement at the moment on the possible relationships to species of other genera with a similar exoperidium, it is my conviction the *Lycoperdon* spp. with a setose exoperidium are rather closely related.

It is common in *Lycoperdon*, especially among the species of the *L. molle* group, to have thicker walled spherocysts at the base of the spines than at the top. From this standard situation, one may derive exoperidia where all spherocysts are rather thin-walled (*L. marginatum*, *L. perlatum*) and exoperidia entirely composed of thick walled elements like those described here.

The key species in this transition is *L. echinatum* (and the related *L. americanum*) where it has been well known since the work of Kreisel (1962) that there is a striking contrast between the large thick walled spherocysts that form the base of the spines and the interjacent reticulation and the thinner walled narrow elements of the spines. Without being setiform, the basal spherocysts of *L. echinatum* are frequently elongated and of irregular outline like some elements found beside the setae in *L. atrum*. The presence of caducous spines made up of thin walled hyphae in some collections of *L. atrum* perfects the comparison. Two characters are important to support a relationship between *L. echinatum* and *L. atrum* : the greyish lilacine tinge of the gleba (in *L. echinatum* mostly in unripe specimens) and the cottony, unclearly lacunar subgleba. The verrucae of the spores are about the same height in both species and point in their relationship to the *L. molle* group, while, if the capillitium lacks any pores in *L. atrum*, they are frequently quite inconspicuous in *L. echinatum*.

Two other species are also important for understanding the transition between the *L. molle* group and species with setose exoperidium.

One is *L. bispinosum* Yasuda, known to me only through the type specimen (isotype, or even holotype ?) in the Lloyd collection (cat. 24801, BPI). In this species, the spines do not fall leaving a reticulum but are conspicuously distinguished from the dark basal layer of thick walled spherocysts through their pale colour.

The other species is very close to *L. atrum*, of which it constitutes a kind of African vicariant : it is *Lycoperdon umbrinoides* Dissing et Lange, also described a few years later as *L. ashantiense* Dring. Of this species, I have studied in detail the type of *L. umbrinoides* (BR) and an isotype of *L. ashantiense* communicated by Dr. Dring (LG) and seen other collections in K. I find it differs from *L. atrum*, with which it even shares peculiar characters like the oblong bodies (persistent basidia ?) in the mature gleba only in the exoperidium. At gleba level, the spines are rather long and blackish, made up of thin-walled, elongated elements disposed in chains like in *L. echinatum* and pass to irregular thick-walled spherocysts, some of them setiform (ex. : 52 x 14 µ, wall 2,3 µ). On the subgleba, the contrast between the tips of the spines and their bases is even stronger, the tips being pale and the bases having a greater proportion of more setiform elements. At this level the spines are quite fragile and caducous and, after their fall, the exoperidium is locally truly setose (setae e.g. 100 x 12 µ,wall 2,5 µ), making this species a perfect intermediate between *L. echinatum* and *L. atrum*.

In the case of *L. setiferum*, the spores and to some degree the capillitium are very similar to those of *L. atropurpureum* and the former species lacks the peculiar subgleba and colour of the gleba of *L. echinatum, atrum*, etc. I therefore consider it probably evolved in a parallel way from *L. atropurpureum*. This would mean an origin distinct from that of the other setiferous species, though still from the *L. molle* group.

In *L. pyriforme*, most of the spherocysts are usually not setiform, but, except for their length/breadth ratio, they are very close to those of *L. melanesicum*, and the proximity of the two species has already been discussed. I consider them derived from fungi similar to *L. atrum*, the warts on the spores of which have become so small as to be invisible without special staining or electron microscopy and which have acquired a number of generative hyphae in the endoperidium. From the standpoint of endoperidial structure, one may note that the very strongly dextrinoid hyphae of *L. atrum* are already similar to those of *L. pyriforme* and that the dehiscence is by nearly total disappearance of these hyphae a character opposed to the tendency toward swelling and septation which occurs in so many species. One will also note that in *L. atrum*, the subgleba is paler than usual and there is an occasional dextrinoid reaction of spherocyst walls.

Figure 11 extracted from an unpublished scheme of possible *Lycoperdon* phylogeny will summarize these ideas.

Finally I hope the following key to all species of *Lycoperdon* known to me with unusual spherocysts may help in the determination of the species discussed so far.

Key to *Lycoperdon* with unusual, large, thick-walled spherocysts in their peridium (pore zone excluded).

1 Spherocysts arising from the endoperidium on which they persist after the fall of the caducous exoperidium... 2

1' Spherocysts a part of the exoperidium (separated from the endoperidium by the pseudoparenchymatous layer).. 3

2 Spines brown, slender, falling individually, with large (up to 55 μ), moderately thick walled (up to 1,8 μ) spherocysts at their bases, which separate them clearly

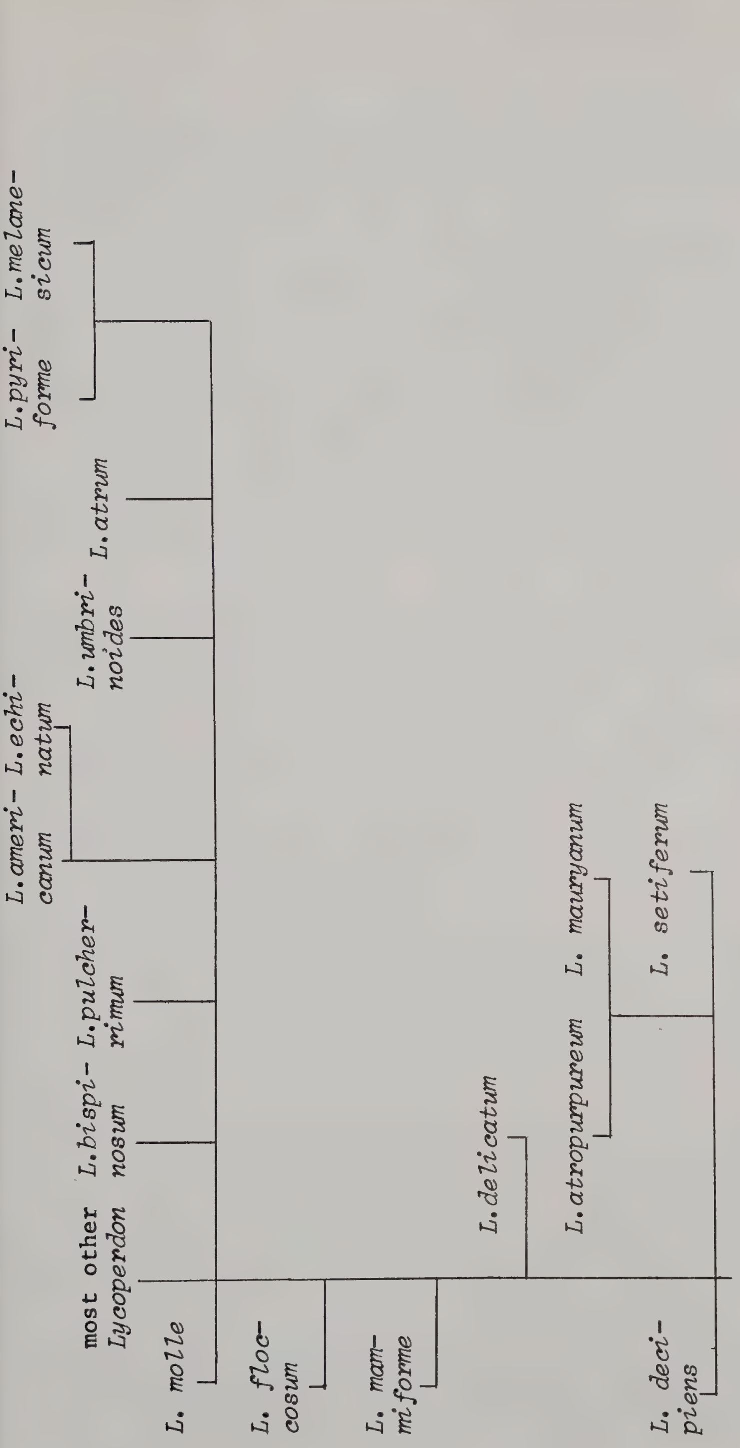

L. molle
L. floccosum
L. mammiforme
L. decipiens
most other Lycoperdon
L. bispinosum
L. pulcherrimum
L. americanum
L. echinatum
L. umbrinoides
L. atrum
L. pyriforme
L. melanesicum
L. delicatum
L. atropurpureum
L. mauryanum
L. setiferum

Fig. 11. Proposed phylogeny of *Lycoperdon* with setose exoperidium and related species.

from the pseudoparenchymatous layer. Growing in woods of Eastern U.S.A. and Mexico .... *L. calvescens* Berk. et Curt.,
Grevillea II (16) : 50 (1873)

2' Spines white, pyramidal, falling in plates for they are not well separated from the pseudoparenchymatous layer (spherocysts thin walled, up to 25 μ). Species of open habitats in several parts of the world, with a preference for a continental climate .... *L. marginatum* Vitt. ex Moris et De Not.,
Fl. Caprariae : 226 (1839)
Syn. : *L. cruciatum* Rostk., *L. candidum* Auct. non Pers.

N.B. In *L. marginatum* and *L. calvescens*, do not confuse spherocysts belonging to the endoperidium with those from the exoperidium.

3 Brown-walled spherocysts forming a reticulum on top of the fruitbodies after the fall of the caducous spines 4

3' No reticulum 5

4 Spines comparatively slender,up to 3 mm long. Spherocysts of the areolae with relatively regular outlines and moderately thick walls, up to 1,8 μ. Spores 4,1-4,4-5,4-5,8 μ. In deciduous woods of Eastern North America .... *L. americanum* Demoulin,
Lejeunia, N.S., 62:2 (1972)

4' Spines very strong, somewhat pyramidal, up to 5 mm long. Spherocysts of the areolae with irregular outlines and walls up to 3-4 μ thick. Spores 3,8-4,1-4,6-5,1 μ. In deciduous woods of Europe .... *L. echinatum* Pers. per Pers.,
Synop.method.Fung. : 147 (1801)

N.B. A species of the *echinatum* group occurs in the NW Himalayas, but not enough material has yet been collected to define its identity adequately.

5 Presence of permanent spines made up of relatively thin-walled elongated rectangular elements disposed in chains on top of a basal layer of irregular thick walled spherocysts 6

5' Spines lacking or fugacious, the exoperidium being mostly velutinous or granular and composed of irregular, thick-walled spherocysts 7

SEE ERRATA

6 Spines on top of the fruitbody blackish, concolorous with the basal layer, which is made up of elements of setiform type, especially near the base of the fruitbody. Tropical Africa .... *L. umbrinoides* Dissing et Lange,
Bull. Jard. Bot. Etat XXXII (4) : 344 (1962)
Syn. : *L. ashantiense* Dring,
Mycol. Pap. 98 : 42 (1964)

6' Spines on top of the fruitbody cream, in contrast to the dark brown basal layer, made up of rather isodiametric but irregularly shaped spherocysts; the subgleba exoperidium has ordinary, isodiametric, thin-walled spherocysts. Japan....... *L. bispinosum* Yasuda,
Bot.Mag. (Tokyo) XXXVII (439-444) : 130 (1923)

7 Subgleba white or lacking. Endoperidium composed of thin-walled, septate and thick-walled aseptate hyphae. Spores smooth. Paracapillitium abundant. Lignicolous species with well developed rhizomorphs 8

7' Subgleba coloured. Endoperidium of aseptate thick walled hyphae. Spores verrucose. Paracapillitium little developed 9

8 Subgleba lacking or with a very few inconspicuous lacunae. Exoperidium from large (e.g. 100 x 20 μ, wall 2,6 μ) setae with branched root-like bases (Fig. 1d, 10). Known until now only from New Guinea, Solomon and Fiji Islands .... *L. melanesicum* Demoulin

8' Subgleba with obvious lacunae. Exoperidium with elements very irregular in shape but seldom elongated. Subcosmopolitan .... *L. pyriforme* Schaeff.per Pers.,
Synop.method.Fung.: 148 (1801)

9 Spores moderately but densely verrucose (10-16 warts for 10 μ of circumference), mixed with oblong bodies having cyanophilous content (Fig. 1a, 5). Subgleba cottony, with obscure lacunae. Gleba with a greyish lilacine tint. Tropical Americas... *L. atrum* Pat.
(Syn. : *L. juruense* P.Henn.)

9' Spores strongly but sparsely verrucose (7-9 warts for 10 μ of circumference), not mixed with oblong bodies (Fig.1b,6). Subgleba of the usual lacunose type.Gleba purplish brown. W. Himalayan region, Japan (?) .... *L. setiferum* Demoulin

SEE ERRATA

REFERENCES

CALONGE, F.D. & DEMOULIN, V. 1975. Les Gastéromycètes d'Espagne. Bull. Soc. Mycol. France 91 (2) : 247-292.

DENNIS, R.W.G. 1953. Some West Indian Gasteromycetes. Kew Bull. 1953 (3) : 307-328, 21 fig.

GROSS, G. & SCHMITT, J. 1974. Beziehungen zwischen Sporenvolumen und Kernzahl bei einiger höheren Pilzen. Z. Pilzk. 40 (3-4) : 163-214, 16 fig.

KREISEL, H. 1962. Die *Lycoperdaceae* der Deutschen Demokratischen Republik. Feddes Repert. 64 (2/3) : 89-201, 3 fig., Tf. I-IX.

KREISEL, H. 1964. Vorläufige Übersicht der Gattung *Bovista* Dill. ex Pers. Feddes Repert. 69 (3) : 196-211, 1 fig., Tf. IX-XI.

KREISEL, H. 1967. Taxonomisch-Pflanzengeographische Monographie der Gattung Bovista. Beih. Nova Hedwigia 25 : VIII + 244 pp., 70 fig.

KREISEL, H. & DRING, D.M. 1967. An emendation of the genus *Morganella* Zeller (*Lycoperdaceae)*. Feddes Repert. 74 (1/2) : 109-122, 3 fig., t. I-II.

MYCOTAXON

Vol. III, No. 2, pp. 297-317 January-March 1976

MYXOMYCETES OF MEXICO I

Karl Leo Braun
Biology Department, North High School
Springfield, Ohio 45503

and

Harold W. Keller
Department of Biological Sciences
Wright State University
Dayton, Ohio 45431

ABSTRACT

Eighty-six species of Myxomycetes are reported from Mexico, 48 of them for the first time. Field collected specimens were made from ground sites by the senior author in seven of the twenty-nine states of Mexico: Guerrero, Yucatán, Jalisco, Chihuahua, México, Morelos and San Luis Potosí. Also included are collections from seven additional states which were studied in Dr. Guzmán's Herbarium at the Instituto Politécnico Nacional, Escuela Nacional de Ciencias Biológicas. One collection was made by Dr. G. W. Martin from a moist-chamber development that apparently represents an undescribed species of *Colloderma*. Another moist-chamber collection made by the authors is believed to represent a new species of *Echinostelium*. Nomenclature follows that of Martin and Alexopoulos (1969). Specimens have been placed in the National Fungus Collections and are retained in the private herbaria of the authors.

ABSTRACTO

Ochenta y seis especies de mixomicetos están reportadas de México, cuarenta y ocho de ellas por primera vez. Los especímenes coleccionados en el campo fueron encontrados por el mayor autor en

SEE ERRATA

siete de los veinte y nueve estados de México: Guerrero, Yucatán, Jalisco, Chihuahua, México, Morelos, y San Luis Potosí. También incluidas son colecciones de siete estados adicionales, las cuales fueron estudiadas en el herbario seco del Dr. Gastón Guzmán en el Instituto Politécnico Nacional, Escuela Nacional de Ciencias Biológicas. Una colección, hecha por el Dr. G. W. Martin de un desarrollo en cámara húmeda, aparentemente representa una especie indescrita de *Colloderma*. Otra colección hecha por los autores en cámara húmeda se cree representar una especie nueva de *Echinostelium*. La nomenclatura sigue la de Martin y Alexopoulos (1969). Los especímenes ya están colocados en el herbario seco de National Fungus Collections y también están retenidos en el privado herbario seco de los autores. (JRB)

AUSZUG

Achtundsechzig Gattungen von Myxomycetes werden behandelt, 48 davon zum ersten Mal. Im Feld gesammelte Exemplare wurden vom ersten Verfasser aus sieben der 29 Staaten von Mexiko genommen: Guerrero, Yucatán, Jalisco, Chihuahua, Méxiko, Morelos, und San Luis Potosí. Eingeschlossen sind auch Sammlungen aus sieben anderen Staaten, die in Doktor Guzmán's Pflanzensammlung bei der Instituto Politécnico Nacional, Escuela Nacional de Ciencias Biológicas untersucht wurden. Eine Sammlung wurde von Doktor G. W. Martin in einer Feuchtkammer erzeugt, die eine bis jetzt unbeschriebene Gattung, anscheinend von *Colloderma,* darstellt. Noch eine andere Feuchtkammersammlung von den Verfassern soll eine neue Gattung von *Echinostelium* darstellen. Die Fachsprache entspricht Martin und Alexopoulos (1969). Die Exemplare sind in die Pflanzensammlung von National Fungus Collections und in die privaten Sammlungen der Autoren untergebracht worden. (DMR)

INTRODUCTION

A study of the pertinent literature shows that little has been written about the plasmodial slime molds of Mexico, a point of view confirmed by Dr. Gastón Guzmán in personal communication with the senior author.

The earliest report found concerning the Myxomycetes of Mexico was by Macbride and Smith (1896) who listed 13 species. Emoto (1933) published an additional 23 species and Alexopoulos (1968) followed by Guzmán (1972) each added one more. In this paper 48 species new to Mexico are reported, bringing the total to 86.

It is surprising that more has not been published on the plasmodial slime molds of Mexico, for during the rainy season (May to October) conditions are such that luxurient myxomycete fruitings take place. Guadalajara has proved to be an especially good collecting area, although the region surrounding Taxco has been equally productive.

This is the first in a series of papers dealing with the Myxomycetes of Mexico. The collections discussed in this paper have been made primarily on decaying wood and leaf litter (ground sites), although Dr. Martin's collection was made as a moist-chamber development from the bark of a living "long leaf pine". The next paper in the series will place special emphasis on the corticolous slime molds harvested from moist-chambers.

It is hoped that this paper will encourage other myxomycetologists to consider Mexico as a productive area for collections.

The following is a list of all species collected in Mexico that have been published, not including the 48 species new to Mexico reported later in this paper. After each scientific name is the name of the individual reporting the collection, according to the following legend:

T. H. Macbride	(Mac)
Y. Emoto	(E)
K. L. Braun	(B)
C. J. Alexopoulos	(A)
G. Guzmán	(G)

I. CERATIOMYXACEAE
Ceratiomyxa fruticulosa (Müll.) Macbr. (E,G,B)
II. LICEACEAE
Licea pedicellata (H. C. Gilbert) H. C. Gilbert (B)
Listed from Mexico in Martin and Alexopoulos (1969)
III. RETICULARIACEAE
Lycogala epidendrum (L.) Fries (Mac,E,B,G)
IV. CRIBRARIACEAE
Dictydium cancellatum (Batsch) Macbr. (E)
V. TRICHIACEAE
Arcyria cinerea (Bull.) Pers. (E,B)
A. denudata (L.) Wettst. (Mac,E,B,)
Hemitrichia serpula (Scop.) Rost. (Mac,B)
Metatrichia vesparium (Batsch) Nann.-Brem. (Mac)

Perichaena chrysosperma (Currey) A. Lister (E,B)
Trichia decipiens (Pers.) Macbr. (Mac)
T. favoginea (Batsch) Pers. (Mac,G)
T. verrucosa Berk. (Mac)

VI. STEMONITACEAE

Comatricha longa Peck (E)
C. pulchella (C. Bab.) Rost. (Mac,G)
C. typhoides (Bull.) Rost. (Mac,E,B)
Stemonitis pallida Wingate (E)
S. smithii Macbr. (Mac)
S. splendens Rost. (E,G)
S. trechispora (Torrend) Macbr. (E)

VII. PHYSARACEAE

Badhamia affinis Rost. (E,B,G)
Craterium leucocephalum (Pers.) Ditmar (E,B)
Fuligo septica (L.) Wiggers (Mac,G)
Physarella oblonga (Berk. and Curt.) Morgan (E)
Physarum compressum Alb. and Schw. (E,B)
P. globuliferum (Bull.) Pers. (E,B)
P. nicaraguense Macbr. (E)
P. nutans Pers. (Mac,E,B)
P. oblatum Macbr. (E)
P. stellatum (Massee) Martin (E)
P. sulphurium Alb. and Schw. (E)
P. tenerum Rex (E,B)
P. vernum Somm. Listed from Mexico in Martin & Alexopoulos (1969)

VIII. DIDYMIACEAE

Diderma effusum (Schw.) Morgan (E,B)
D. hemisphaericum (Bull.) Hornem. (E,B)
Didymium clavus (Alb. and Schw.) Rab. (E,B)
D. nigripes (Link) Fries (E,B)
D. squamulosum (Alb. and Schw.) Fries (E,B)
Physarina echinospora Thind and Manocha (A)

The Mexican Myxomycetes reported here for the first time in the literature represent collections made in 12 states of Mexico. Although collections were made from Puebla and Oaxaca, none of these species is new to Mexico. To prevent redundancy in the collection data, the states are listed below with their average temperature (C) and average rainfall for a five year period.

State	Month	Temperature	Rainfall (cm)
Chihuahua	June	26	2.5
Colima	October	26	7.75
Guerrero	July	21	30.5
	August	21	34.5
Hidalgo	June	16	7.0
Jalisco	June	22	19.3
	July	20	25.4
México	June	16	12.4
	July	16	12.5
	September	16	11.7
	October	15	3.3
	November	13	1.6
Morelos	July	20	21.8
	August	20	22.1
San Luis Potosí	July	20	5.8
Sonora	September	31	8.4
Tlaxcala	April	17	1.75
Veracruz	April	25	2.1
	July	27	35.1
Yucatán	December	23	3.1

The map (Fig. 1) shows the areas in which collections were made.

REPUBLICA MEXICANA

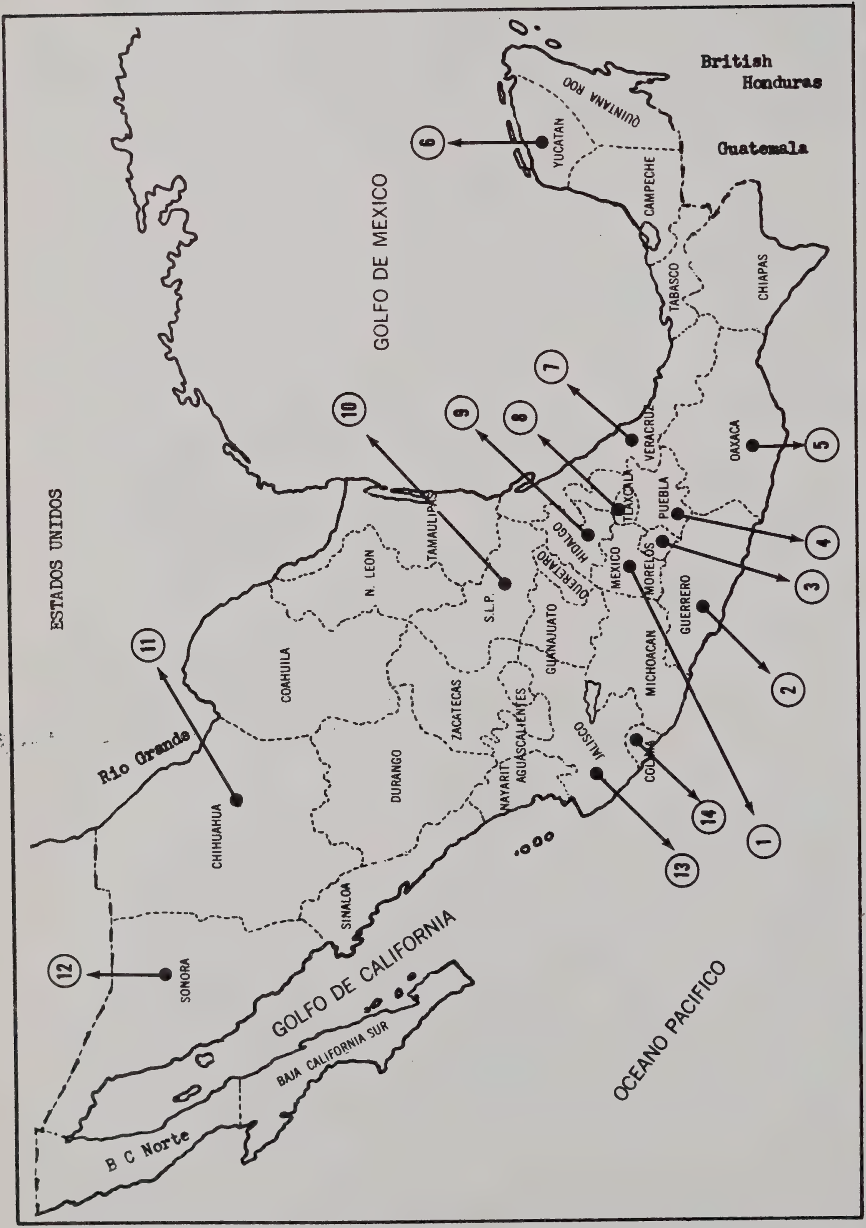

ESTADOS UNIDOS
GOLFO DE MEXICO
British Honduras
Guatemala
QUINTANA ROO
YUCATAN
CAMPECHE
TABASCO
CHIAPAS
OAXACA
VERACRUZ
PUEBLA
TLAXCALA
HIDALGO
QUERETARO
MEXICO
MORELOS
GUERRERO
MICHOACAN
COLIMA
JALISCO
GUANAJUATO
AGUASCALIENTES
NAYARIT
ZACATECAS
S.L.P.
TAMAULIPAS
N. LEON
COAHUILA
DURANGO
CHIHUAHUA
SINALOA
SONORA
Rio Grande
GOLFO DE CALIFORNIA
BAJA CALIFORNIA SUR
B C Norte
OCEANO PACIFICO
1
2
3
4
5
6
7
8
9
10
11
12
13
14

Figure 1. Map of Mexico showing 29 states and 2 territories. The states in which collections have been made are numbered.

SEE ERRATA

In the following list, 48 Myxomycetes are reported as new to Mexico, along with the appropriate collection data. Collections are discussed only when the authors feel that they differ significantly from the species descriptions given in Martin and Alexopoulos (1969). IPN numbers indicate specimens in the herbarium of the Instituto Politécnico Nacional collected by Dr. Guzmán and his students.

LICEACEAE

Licea minima Fries, Syst. Myc. 3:199. 1829

Tlaxcala (8), see map. Texcoco and Capalupán, km 66-67 on rte 136. Low, rolling, pine covered hills. Harvested from moist-chamber by Dr. G. W. Martin 4-13-68, alt. ca. 2231m (GWM 9027, KLB 616)

RETICULARIACEAE

Reticularia intermedia Nann.-Brem.,Med.Bot.Mus. Utrecht 149: 773. 1958.

Jalisco (13). Guadalajara, Parque Agua Azul. On dead tree stump, 6-27-71, alt. ca. 1579m (KLB 581)

Tubifera ferruginosa (Batsch) J.F. Gmel.,Syst.Nat. 2: 1472.1791.

México (1). Carretera México, Toluca, La Venta, México, Conifer forest, 10-16-70, alt. ca. 2638m (IPN 54)

SEE ERRATA

Morelos (3). Km 32 Autopista Mex. Cuernavaca, Pine woods, 7-21-68, alt. ca. 2900m (IPN 6801)

Hidalgo (9). Bosque Real de Huasca, 2 km SE of Huasca, Pinus-quercus woods, 6-24-73, alt. ca. 2150m (IPN 262)

Tubifera microsperma (Berk. and Curt.) Martin,Mycologia 39: 461 1947.

Veracruz (7). Ocotopec. Municipio de Jalacingo, Oak forest, 7-4-70, alt. ca. 1700m (IPN 1513)

CRIBRARIACEAE

Cribraria argillacea (Pers.) Pers.,Neues Mag. Bot. 1: 91. 1794.

México (1). Llano Grande, carretera México a Río Frío, Pine woods, 7-26-70, alt. ca. 3100m(IPN 7967)

Cribraria violacea Rex, Proc. Acad. Phila. 43: 393. 1891

Yucatán (6). Uxmal, near pyramid of Magician. Bark of living tree, not identified, 12-24-74. Moist-chamber wetted, 1-3-75, harvested 1-20-75, alt. ca. 65m (KLB 619)

ECHINOSTELIACEAE

Echinostelium minutum de Bary, in Rost. Mon. 215. 1874.

Yucatán (6). Kabah, near entrance to archeological grounds, 12-24-74. Moist-chamber wetted 1-3-75, harvested 1-15-75, alt. ca. 65m (KLB 623)

Echinostelium sp. (To be published elsewhere as a new species.)

Yucatán (6). Kabah, 12-24-74. Moist-chamber wetted 1-3-75, harvested 1-15-75, alt. ca. 65m (KLB 624, HWK 1381, 1383, 1396, 1416)

TRICHIACEAE

Arcyria insignis Kalchbr. and Cooke, in Kalchbr., Grevillea 10: 143. 1882.

Guerrero (2). Taxco, San Francisco Cuadra along bank of Río Cuadra, on decaying wood, 7-2-71, alt. ca. 1705m (KLB 541)

Arcyria leiocarpa (Cooke) Martin and Alexop. in Martin and Alexopoulos. Myxomy. 131. 1969.

Guerrero (2). Taxco, San Francisco Cuadra along bank of Río Cuadra, on decaying wood, 7-2-71, alt. ca. 1705m (KLB 544)

Discussion: This species has a widely scattered distribution throughout the world, but is seldom reported apparently due to its confusion with *Arcyria cinerea* (Bull.) Pers. Our collection consists of a number of sporangia, tightly clustered in groups of 6 to 20. The ochraceous color of the sporangia is quite obvious in our material. Martin and Alexopoulos (1969) note that on the capillitial threads "...the loose spirals look spiny, particularly on the outside of curves, but careful examination will show that these are not spines,..." In our specimens the spines are clearly evident on the conspicuous spirals, although portions of the capillitium consist of smooth spiral bands. Martin and Alexopoulos

(1969) transferred this species from *Hemitrichia* to *Arcyria* and in so doing emphasized the arcyria-like habit of the sporangia and arcyriaceous organization (elastic network) of the capillitium. In any event this is quite a distinct species and the suggestion by Martin and Alexopoulos (1969) that it be considered a variety of *A. cinerea* has little merit.

Arcyria nutans (Bull.) Grev., Fl. Edin. 455. 1824

Hidalgo (9). Las Ventanas, Parque Nacional El Chico, Abies forest, on dead wood, 6-9-68, alt. ca. 3000m (IPN 6585)

Colima (14). East of Santiago, Carretera Manzanillo, tropical vegetation, on dead wood, 10-26-67, alt. ca. 20m (IPN 6230)

Calonema luteolum Kowalski, Madroño, Vol. 20: 4. 1969.

México (1). Teotihuacán, SE of Pirámide del Sol, found associated with *Hemitrichia karstenii* on leaf litter, 6-30-71, alt. ca. 2278m (KLB 514)

Discussion: This collection agrees with the original description except that the sporangia developed on plant litter rather than on dung of herbivorous animals, the usual substratum for this species. Kowalski (1969) acknowledges the similarity of *C. luteolum* to the genus *Perichaena* in the capillitial and spore characteristics but later puts more emphasis on the differences, "Species of *Perichaena*, however, have a two-layered peridium and the sporangia, while they may be clustered, are never heaped." *Perichaena quadrata* Macbr. has heaped sporangia and the upper half of the sporangia is dark and double-walled whereas the membranous lower half of the sporangia is more brightly colored and single-walled (Keller, 1971). *Perichaena microspora* Penz & A. Lister has a membranous peridium that appears single. In addition the perichaenoid capillitium of *C. luteolum* is identical to that of *P. quadrata* and *P. depressa* Libert which according to Keller, 1971 has "...close-set constrictions at regular intervals, appearing as annulae in surface view and as septations in optical sections;..".

SEE ERRATA

Electron micrographs of capillitial threads of *P. depressa* (collection HWK 520) clearly show that the so-called annulae and septations are wedge-shaped intrusions of the wall into the lumen of the thread and more accurately can be described as partial septations (unpublished observations by one of us HWK). The two species, *P. quadrata* and *C. luteolum*, may be conspecific with *P. liceoides* Rost. *Calonema luteolum* agrees with Rostafinski's description of *P. liceoides* in every detail except that in the latter species the capillitium is usually more scanty or completely lacking. There is some doubt whether or not Rostafinski's type still exists, but if it does, and if it is identical with *P. quadrata* or *C. luteolum*, then the epithet *liceoides* has priority.

Hemitrichia karstenii (Rost.) A. Lister, Mycet. 178. 1894.

México (1). Teotihuacán, found on leaf litter, 6-30-71, alt. ca 2278m (KLB 588)

Perichaena depressa Libert, Pl. Crypt. 378. 1837.

Yucatán (6). Uxmal, near pyramid of Magician. Moist-chamber collection from bark of living tree (unidentified). Bark collected 12-24-74, wetted 1-3-75, harvested 1-15-75, alt. ca. 65m (KLB 618)

Hemitrichia calyculata (Speg.) Farr, Mycologia 66: 887. 1974.

Jalisco (13). Guadalajara, on dead wood, 6-25-71, alt. ca. 1579m (KLB 597)

Guerrero (2). Taxco, San Francisco Cuadra along the Río Cuadra, on dead wood, 7-2-71, alt. ca. 1705m (KLB 507)

Morelos (3). 5km NW of Tepoztlán, near autopista to Cuatla, on wood in subtropical forest of Quercus, 8-16-70, alt. ca. 1400m (IPN 8052)

Trichia varia (Pers.) Pers., Neues Mag. Bot. 1: 90. 1794.

Veracruz (7). Jalapa, early April, 1894. Legit: C. L. Smith, Fide: G. W. Martin. alt. ca. 1362m

STEMONITACEAE

Colloderma sp.

México (1). Cerro Cualtepec, near Sultepec, on bark of living long-leaved pine, bark taken from 1.4m above ground, 9-30-66, alt. ca. 2480m (GWM 9025)

Discussion: On bark of living *Pinus* (unidentified) in moist-chamber. The bark sample on which this specimen appeared was gathered by Dr. Paul Sorensen. Dr. G. W. Martin placed part of this bark sample in a moist-chamber in October, 1966 and incubated it at room temperature. Aside from an abundance of *Echinostelium minutum* deBary, it produced only molds, and was discarded. The remainder was cultured similarly on January 28, 1967, but this time it was placed in an incubator at 18 C. Here, in addition to the *E. minutum,* it produced *Licea minima* Fries in small quantities and the *Colloderma* in great abundance. The fructifications developed very slowly, taking about two weeks to attain full maturity, but continued to appear over a period of about three months. In personal notes given to one of us (HWK) by Dr. Martin shortly before his death, this *Colloderma* was considered an undescribed species and given a provisional name. There is no question that this specimen is quite different from *Colloderma oculatum* (Lippert) G. Lister but it is similar in many ways to *Colloderma robustum* Meylan. We believe more collections are needed before a decision can be made as to whether this material represents a new species or is assignable to *C. robustum.* Therefore, only a detailed description and a discussion of our specimen is provided at this time.

Sporangia sessile, pulvinate, clustered or scattered on a broad or somewhat constricted base, circular or somewhat elongated but scarcely plasmodiocarpous except by fusion of adjacent sporangia, 0.4-0.8 mm diameter, rarely exceeding twice the diameter in length, dark brown; peridium double, the outer layer thick, nearly colorless, with included brownish granules and waste material from the substratum, gelatinous when moist, shrinking and appressed against the inner membranous and shiny layer when dry, the combined layers tough-cartilaginous; hypothallus colorless, thin, scarcely visible when moist and rarely visible when dry, but apparently continuous with the gelatinous outer wall; columella none; capillitium a delicate network of slender mostly colorless to pale brownish threads, the junctions few and only slightly enlarged and occasionally with swellings; spores globose, deep brown in mass, yellowish brown and paler on one side by transmitted light, densely and conspicuously spiny, the spines appearing longer and darker on one side, 14 - 16 µm in diameter including the ornamentation. Phaneroplasmodium dingy white on emergence, changing through dull pinkish and dingy ochraceous to brown.

In its general habit, peridial characteristics and in the size and spiny spores this specimen closely resembles *C. robustum*, from which it differs in its very delicate and rather scanty almost colorless capillitium (giving a hoary appearance in blown out sporangia) and in the somewhat browner color of the spores which have longer spines on one side and a distinct paler area on the opposite side. Dr. D. T. Kowalski, who has examined Meylan's type (Kowalski, 1975) and who kindly examined our specimen, noted in a personal communication that our specimen was "...very close to, if not identical with *C. robustum*. I have examined two collections of *C. robustum*, one from Poland and Meylan's type from Switzerland, and while there are some differences, they are minute." and with this we are in general agreement.

Comatricha elegans (Racib.) G. Lister, Guide Brit. Mycet. ed. 3. 31. 1909.

Jalisco (13). Guadalajara. 1579m on dead wood. 6-27-71. (KLB 613)

Discussion: Our specimen is a typical example of this species in which the abundant capillitium is well developed as an intricate system of threads that branch and anastomose eventually terminating in many free ends. Raciborski's type was examined and found to be identical with our specimen. Over the years one of us (HWK) has made numerous collections of a *Comatricha* from the bark of living trees that was provisionally assigned to *C. elegans* even though the capillitium was

SEE ERRATA

less abundant, seldom branched and was united at the periphery into a surface net with few or no free ends. This taxon is close to *Paradiacheopsis cribrata* Nann. Brem. except for the consistantly smaller spores of 8-9.5 µm. Additional specimens and types must be studied before the exact taxonomic status of this *Comatricha* from living trees can be determined.

Comatricha subcaespitosa Peck, Ann. Rep. N.Y. State Mus. 43: 71. 1890.

San Luis Potosí (10). Valles, growing on well rotted material (one of the fleshy fungi) on soil. 7-19-58 alt. ca. 89m (KLB 503)

Comatricha tenerrima (M.A. Curt.) G. Lister, Guide Brit. Mycet. ed. 4. 39. 1919.

Guerrero (2). Taxco, San Francisco Cuadra along Río Cuadra near the hacienda, on dead wood, 7-2-71, alt. ca. 1705m (KLB 538)

Lamproderma arcyrionema Rost., Mon. 208. 1874.

Guerrero (2). Taxco, San Francisco Cuadra, Río Cuadra, on leaf litter, 7-2-71, alt. ca. 1705m (KLB 535)

Lamproderma echinulatum (Berk.) Rost., Mon. App. 25. 1876.

México (1). La Marquesa, Parque Nacional Miguel Hidalgo, dead wood, Abies forest, 6-16-68, alt. ca. 3000m (IPN 12). The identification of this specimen has been verified by Dr. D. T. Kowalski.

Discussion: This collection represents the first record for the New World. Although the sporangia are in poor condition and moldy due to excessive weathering, they agree in detail with the species description in Martin and Alexopoulos (1969).

Macbrideola cornea (G. Lister and Cran) Alexop., Mycologia 59: 112. 1967.

Yucatán (6). Uxmal, from living tree (unidentified). Collected 1.24m above ground, 12-24-74. Wetted

SEE ERRATA

3-18-75, harvested 3-24-75, alt. ca. 65m (KLB 511)

Stemonitis axifera (Bull.) Macbr.,N. Amer. Slime-Moulds 120.1889.

México (1). Barranca de Ameyallo, Camino Amecameca, Tlamacas. Dead wood, Abies forest, 6-26-72, Alt. ca. 3000m (IPN 10051)

Stemonitis fusca Roth, Mag.Bot. Römer and Usteri 1 (2): 26.1787.

Chihuahua (11). Creel, near train station, found on Ponderosa Pine (on dead wood) 6-17-71, alt. ca. 2250m (KLB 558)

Stemonitis virginiensis Rex, Proc.Acad.Phila. 43: 391. 1891.

Morelos (3). Cuernavaca (Cortez Palace), found on living grass at base of tree stump, 7-21-72, alt. ca. 1550m (KLB 578)

PHYSARACEAE

Badhamia gracilis (Macbr.) Macbr., in Macbr. and Martin, Myxom. 35. 1934.

México (1). Teotihuacán, found at base of "prickly pear" cactus on dead nopal leaf, 7-18-72, alt. ca. 2278m (KLB 506)

Badhamia utricularis (Bull.) Berk., Trans. Linn.Soc. 21: 153.1853.

México (1). 3km sobre la Desviación a Chalma. Bosque de Pinus-Abies. On dead wood, 7-2-71, (IPN 89)

Craterium aureum (Schum.) Rost., Mon. 124. 1874.

Guerrero (2). Taxco, San Francisco Cuadra, along Río Cuadra, found on dead leaf, 7-2-71, alt. ca. 1705m (KLB 525)

Fuligo cinerea (Schw.) Morgan, Jour.Cinc.Soc.Nat.Hist. 19: 33.1896.

Sonora (12). Monte la Esperanza, 4 km NE of Altar. On debris in Bosque de Mezquite, Sept. 1968, alt. ca. 400m (IPN 13)

Physarum bogoriense Racib., Hedwigia 37: 52. 18 F. 1898.

Guerrero (2). Taxco. San Francisco Cuadra, 1550m, on dead tree twig. 7-2-71. (KLB 524)

Discussion: On dead twig as part of ground litter. This collection has the typical sessile fructifications that vary from globose sporangia to elongate, unbranched plasmodiocarps. The peridium dehisces in a stellate fashion, remaining as persistant lobes. The capillitium is distinctly physaroid and is characterized by discrete, rounded lime-knots connected by hyaline threads. The globose spores are free (not clustered), pale brown in mass, and uniformly and faintly warted. This collection, as well as many others from the tropics and subtropics where this species is very common, and others from the temperate and cooler regions of the world where this species tends to be more infrequent, agree well with Raciborski's original description.

The species description of *P. bogoriense* in Martin and Alexopoulos (1969) differs from that of previous monographers (the Listers 1911, 1925; Macbride and Martin 1934; Hagelstein 1944; Martin 1949) and also from Raciborski's original description (1898) in that it is expanded to include "often reticulate plasmodiocarps", in reference to the habit, and "sometimes clustered" in reference to the spores. These changes were prompted by specimens sent to Dr. Martin by Dr. D. T. Kowalski from California which clearly exhibited these characteristics. In their monograph Martin and Alexopoulos (1969) note that "Dr. Kowalski, in correspondence, reports that he has examined Raciborski's type and finds that the spores are clustered, as they are in one of his northern California collections and in Plunkett's 182 from southern California." Much later, after the monograph had gone to press, Dr. Martin had recognized that two taxa were involved here, and that the California material represented a distinct species. In his personal notes he gave the California specimens a new name and tabulated the differences of the two taxa. These differences Dr. Martin described as "The prominently clustered spores which are very dark and much more strongly warted, and the very different peridium..." and later "The thick, tough, smooth, shining peridium of your specimen is not at all like that of what I should call *P. bogoriense* as I know it from the central states and Central America, nor, so far as my rather scanty material permits me to judge, from the Old World tropics."

One of us (HWK) has examined 18 collections gathered by Dr. D. T. Kowalski (DTK 's 1407, 1497, 2466, 5224, 5229, 5237, 5244, 5248, 5252, 5256, 5443, 5487, 5494, 5672, 5675, 5768, 5785, 7954) during December to March in the Sacramento Valley, where this taxon is extremely abundant. This is a lowland taxon, occurring at approximately 100 m elevation on the decaying bark of hardwood logs and also on accumulated dead leaves. A number of characteristics set apart these collections from *P. bogoriense,* some of which were noted by Dr. Martin. These differences include a tendency toward a more robust and intricately branching plasmodiocarpous habit, often becoming reticulate and extending up to 3cm in length; a double peridium greatly thickened and charged with lime that gives a shiny and varnished appearance reminiscent of *Leocarpous fragilis* (Dicks) Rost.; dehiscence by irregular fragmentation but never by preformed lines at the apex or by splitting into lobes along the sides; a more badhamoid capillitium of irregular and branching tubules and in plasmodiocarps the presence of a massive columella that may fill up to half the chamber; and spores almost black in mass, that adhere in loose or tight clusters of variable numbers.

One of us (HWK) has examined all of the specimens identified as *P. bogoriense* in the University of Iowa Myxomycetes collection, as well as collections made in Florida (HWK #'s 318, 326, 793, 977) where the species is extremely common. None of these collections has reticulate plasmodiocarps, a badhamoid capillitium, a conspicuous columella, or clustered spores and indeed differ in many significant characteristics from the California material. Raciborski's original description in German (1898), and the descriptions of later monographers such as the Listers (1911, 1925), Macbride and Martin (1934), Hagelstein (1944), Martin (1949) accurately and correctly circumscribe *P. bogoriense*. Our examination of many collections of *P. bogoriense* supports the findings of earlier monographers and a brief summary of salient features follows: the peridium is double and the outer layer splits into lobes which separate above but

SEE ERRATA

remain attached below, exposing the membranous inner peridium; the capillitium is distinctly physaroid, the small usually rounded or irregular lime-knots rarely collect in the center suggesting a pseudocolumella, but a true columella is absent; the spores are free and brown in mass.

There appear to be two strikingly different and distinct taxa involved here, not a single variable species linked by collections of an intermediate nature. Nevertheless, the taxonomic status of *P. bogoriense* remains in doubt since our repeated attempts to obtain Raciborski's type have been unsuccessful. As noted above, Dr. Kowalski believes Raciborski's type is the same as his California material. If Raciborski's original description accurately describes the type specimen, as we believe it does, then the type of dehiscence alone would rule out the possibility that the California material is the same. It appears to us that the California material, previously included in the species description of *P. bogoriense* by Martin and Alexopoulos (1969), is a distinct species, but its taxonomic status must remain uncertain until we can examine the type.

Physarum cinereum (Batsch) Pers., Neues Mag. Bot. 1: 89. 1794.

Guerrero (2). Taxco. San Francisco Cuadra, along the Río Cuadra on leaf litter. 1705m. 7-2-71. (KLB 548)

Jalisco (13). Guadalajara, on dead twig, 6-28-71, alt. ca. 1579m (KLB 573)

Guadalajara, on living grass, 6-25-71, alt. ca. 1579m (KLB 603)

Guadalajara, on living grass, 7-18-72, alt. ca. 1579m (KLB 614)

Physarum ?citrinum Schum., Enum. Pl. Saell. 2: 201. 1803.

Mexíco (1). 3 km sobre la Desviación a Chalma, on dead wood, Bosque de Pinus and Abies, 7-2-71, (IPN 93)

Discussion: Our specimen consists of about 50 fructifications growing on dead wood. Although this specimen is very close to the Martin and Alexopoulos (1969) description, there are some obvious differences and therefore a description of our specimen follows. A similar specimen (TEX 1474) was described by Alexopoulos and Sáenz (1975) which, as they imply, may very well represent a new species.

Sporangia gregarious, many in pairs closely appressed, stipitate, globose to subglobose with slight invagination below, pale yellow, 0.8-1.5mm tall (total), 0.6-0.8mm in diameter; hypothallus venulose, scanty, membranous, yellowish brown; stipe stout, calcareous, erect, tapering upward, yellow, very short to about half total height; columella small, convex, yellow; peridium thin, membranous, covered with yellow calcareous patches, persisting at base of columella; capillitium dense, delicate, consisting of numerous elongated, yellow lime nodes and hyaline connecting filaments; spores dark brown in mass, violaceous brown by transmitted light, 10-12µm in diameter, minutely punctate (1000x) with conspicuous wart clusters.

Physarum melleum (Berk. and Br.) Massee, Mon. 278. 1892.

Guerrero (2). Taxco, San Francisco Cuadra along Río Cuadra, leaf litter, 8-10-75, alt. ca. 1705m (KLB 595)

Jalisco (13). Guadalajara, on dead grass, 6-24-71, alt. ca. 1579m (KLB 609)

Physarum mutabile (Rost.) G. Lister, in Lister, Mycet. ed. 2. 53. 1911.

Jalisco (13). Guadalajara, on living grass, 6-25-71, alt. ca. 1579m (KLB 576)

Physarum penetrale Rex, Proc. Acad.Phila. 43: 389. 1891.

Guerrero (2). Taxco, San Francisco Cuadra, along the Río Cuadra, on dead wood, 8-17-59, alt. ca. 1705m (KLB 505)

Physarum pusillum (Berk. and Curt.) G. Lister, Mycet. ed. 2. 64. 1911.

México (1). Teotihuacán, on leaf litter, 6-30-71, alt. ca. 2278m (KLB 589)

Teotihuacán, in front of Café Pirámide, found on cotton string, 6-30-71, alt. ca. 2278m (KLB 610)

SEE ERRATA

Jalisco (13). Guadalajara, on leaf litter, 6-25-71, alt. ca. 1579m (KLB 602)

Guadalajara, on leaf litter, 6-25-71, alt. ca. 1579m (KLB 591)

Physarum virescens Ditmar, in Sturm, Deuts. Fl. Pilze 1: 123. 1817.

Guerrero (2). Taxco, San Francisco Cuadra, along Río Cuadra on decaying wood. Associated with *Comatricha*. 7-2-71, alt. ca. 1705m (KLB 550)

Physarum viride (Bull.) Pers., Ann. Bot. Usteri 15: 6. 1795

Guerrero (2). Taxco, San Francisco Cuadra, along Río Cuadra, on dead, well decayed tree, 7-2-71, alt. ca. 1705m (KLB 519)

DIDYMIACEAE

Diderma crustaceum Peck, Ann. Rep. N. Y. State Mus. 26: 74. 1874.

Guerrero (2). Taxco, San Francisco Cuadra, along Río Cuadra on dead leaf, 7-2-71, alt. ca. 1705m (KLB 534)

Diderma niveum (Rost.) Macbr., N. Am. Slime-Moulds. 100. 1899.

Guerrero (2). Taxco, San Francisco Cuadra, along Río Cuadra on leaf litter, 8-17-58, alt. ca. 1705m (KLB 503)

Diderma spumarioides (Fries) Fries, Syst. Myc. 3: 104. 1829.

México (1). Carretera México, Amecameca. Bosque de Pinus, Cupressus, Quercus. Found on moss, 11-2-69, alt. ca. 2295m (IPN 68-A)

Diderma testaceum (Schrad.) Pers., Syn. Fung. 167. 1801.

Guerrero (2). Taxco, San Francisco Cuadra along Río Cuadra on dead leaves and moss, 8-17-58, alt. ca. 1705m (KLB 501)

Taxco, Op. cit., on decaying wood, 8-17-59, alt. ca. 1705m (KLB 502)

Didymium anellus Morgan, Jour. Cinc. Nat. Hist. 16: 148. 1894.

Guerrero (2). Taxco, San Francisco Cuadra on dead leaf, 7-2-71, alt. ca. 1705m (KLB 517)

SEE ERRATA

Didymium difforme (Pers.) S.F. Gray, Nat.Arr. Brit.Pl. 1: 571. 1821.

Jalisco (13). Guadalajara, on leaf litter, 6-28-71, alt. ca. 1579m (KLB 572)

Guerrero (2). Taxco, San Francisco Cuadra, along Río Cuadra on leaf litter, 7-2-71, alt. ca. 1705m (KLB 553)

Didymium iridis (Ditmar) Fries, Syst.Myc. 3: 120. 1829.

Guerrero (2). Taxco, San Francisco Cuadra, Río Cuadra, on leaf litter, 7-2-71, alt. ca. 1705m (KLB 615, 619, 620)

Didymium minus (A. Lister) Morgan, Jour.Cinc.Soc.Nat.Hist. 16: 145. 1894.

Guerrero (2). Taxco, San Francisco Cuadra, Río Cuadra, on leaf litter, 7-2-71, alt. ca. 1705m (KLB 621, 513)

Mucilago crustacea Wiggers, Prim.Fl.Holst. 112. 1780. Not *M. crustacea* (L.) Schrank 1789.

México (1). Barranca de Ameyalco, Camino Amecameca, Tlamacas, Abies forest, on moss, 6-26-72, (IPN 198)

ACKNOWLEDGEMENTS

We should like to thank Dr. G. W. Martin who, shortly before his death, provided us with collections and notes of the *Colloderma* and *Liceas* reported here. We wish to thank Dr. D. T. Kowalski for his valuable comments concerning *Colloderma robustum*. Dr. T. E. Brooks and Dr. M. L. Farr identified many of the more difficult specimens and their assistance is greatly appreciated. The senior author wishes to thank Louise Flannery, Jeanne Braun, and Marilyn Lesher for their help in collecting specimens. Special thanks to Herman H. Flannery who made most of the 1971 collections. Thanks also to Dr. Gastón Guzmán of the Instituto Politécnico Nacional, Escuela Nacional de Biológicas, for his help and permission to examine specimens in his herbarium. We should also like to thank Jeanne Braun and David Reichel for their Spanish and German translations of the abstract respectively. This project was supported by NSF Institutional Grant (GU-3646) to Wright State University and awarded through the University Research Council to Harold W. Keller.

SEE ERRATA

LITERATURE CITED

Alexopoulos, C. J. 1968. Taxonomic studies in the Myxomycetes II. Physarina. The Journal of the Elisha Mitchell Sci. Soc. 84: 48-51.

Alexopoulos, C. J. and Jose A. Sáenz R. 1975. The Myxomycetes of Costa Rica. Mycotaxon. Vol. II: 2. 223-271.

Emoto, Yoshikadzu. 1933. Myxomyceten aus Mexiko. The Bot. Mag. XLVII: 132-135.

Farr, M. L. 1969. Myxomycetes from Dominica. Contributions from the United States National Herbarium. Vol. 37. Part 6. (End of Volume). Smithsonian Institution Press. City of Washington. 397-440.

Guzmán, Gastón. 1972. Algunos Macromicetos, Liquenes y Mixomicetos importantes en la zona del Volcán Popocatépetl. Guías botánicas de excursiones en México. Sociedad Botánica de México.

Hagelstein, R. 1944. The Mycetozoa of North America. Mineola, N. Y. 306 pages, 16 plates.

Keller, H. W. 1971. The genus *Perichaena* (Myxomycetes): a taxonomic and cultural study. Ph.D. dissertation, Univ. of Iowa, Iowa City. 199 pages.

Kowalski, D. T. 1969. A new coprophilous species of *Calonema*. (Myxomycetes). Madroño 20: 229-231.

Kowalski, D. T. 1975. The Myxomycete taxa described by Charles Meylan. Mycologia 67: 448-494.

Lister, A. A monograph of the Mycetozoa. ed. 2. 1911; ed. 3. 1925, Revised by G. Lister.

Macbride, T. H. and G. W. Martin. 1934. The Myxomycetes. MacMillan Co. New York. 339 pages. 21 plates.

Macbride, T. H. and C. L. Smith. 1896. The Nicaraguan Myxomycetes. With notes on certain Mexican species. Nat. Hist. Bull. Univ. of Iowa. IV: 73-75.

Martin, G. W. 1949. North Amer. Flora. Vol. I, Part 1, New York Botanical Garden. Ap. 29.

Martin, G. W. and C. J. Alexopoulos. 1969. The Myxomycetes. Univ. of Iowa Press. Iowa City. 561 pages.

Raciborski, M. 1898. Über die javanischen Schleimpilze. Hedwigia 37: 50-55.

MYCOTAXON

Vol. III, No. 2, p. 318 January-March 1976

BOOK REVIEW

by

G. L. HENNEBERT

Book Review Editor, Huttelaan 36, B-3030 Heverlee, Belgium

THE MICROFLORA IN THE SETTLING AND SUBSOIL WATER ENRICHING BASINS OF THE BUDAPEST WATERWORKS. A COMPARATIVE STUDY IN ECOLOGY, LIMNOLOGY AND SYSTEMATICS, par T. HORTOBAGYI, 342 p., 610 fig., 17 × 24 cm, relié, 1973. Akademiai Kiado, Budapest. S 20.20.

Toute étude écologique sérieuse se doit d'être basée sur une taxonomie précise de la flore. L'auteur présente excellement la description taxonomique de 415 espèces (algues pour la plupart, dont 130 *Scenedesmus*, et deux champignons) dans les eaux de Budapest. Il s'adresse aux algologues et aux écologites.

SEE ERRATA

MYCOTAXON

Vol. III, No. 2, pp. 319-324 January-March 1976

A REVISION OF HELOTIOPSIS

MARTHA A. SHERWOOD AND RICHARD P. KORF

Plant Pathology Herbarium, Cornell University
Ithaca, New York 14853 USA

SUMMARY

Three species of *Helotiopsis*, a genus of inoperculate Discomycetes with spherical, ornamented spores, are discussed. Of these, H. jenkinsii is described as new, and H. anonyma is transferred to the genus.

Ornamented ascospores are rare among non-lichenized inoperculate Discomycetes. Attempts to identify a minute Mexican Discomycete with spherical, spinulose spores and inoperculate asci led the authors to *Helotiopsis* von Höhnel, a poorly-known, tropical genus.

Von Höhnel (*1910*) characterized *Helotiopsis* by spherical, smooth or spiny ascospores and a margin constructed of overlapping, pale yellow hyphae with thickened ends. He included one species, *H. apicalis* (Berk. & Br.) v.Höhn., and suggested that *Pezizella anonyma* Rehm was congeneric. Examination of the type material of *P. anonyma* and of *H. apicalis*, and comparison with the Mexican collections, showed all three to be congeneric.

The Mexican fungus appears distinct from the other two species and is here designated *Helotiopsis jenkinsii* in honor of Anna E. Jenkins (Obrien, *1975*), a lifelong friend and benefactor of this Herbarium.

HELOTIOPSIS von Höhnel, Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Cl., Abt. 1, 119: 623. 1910.

Apothecia minute to small, subsessile or short stipitate, light-colored, glabrous to faintly roughened when dry, rather glassy when wet. Excipulum composed at least in part of hyphae with thick, gelatinizing walls, parallel to or at a low angle to the surface. Paraphyses numerous, filiform, gelatinizing in one species. Asci small, cylindrical,

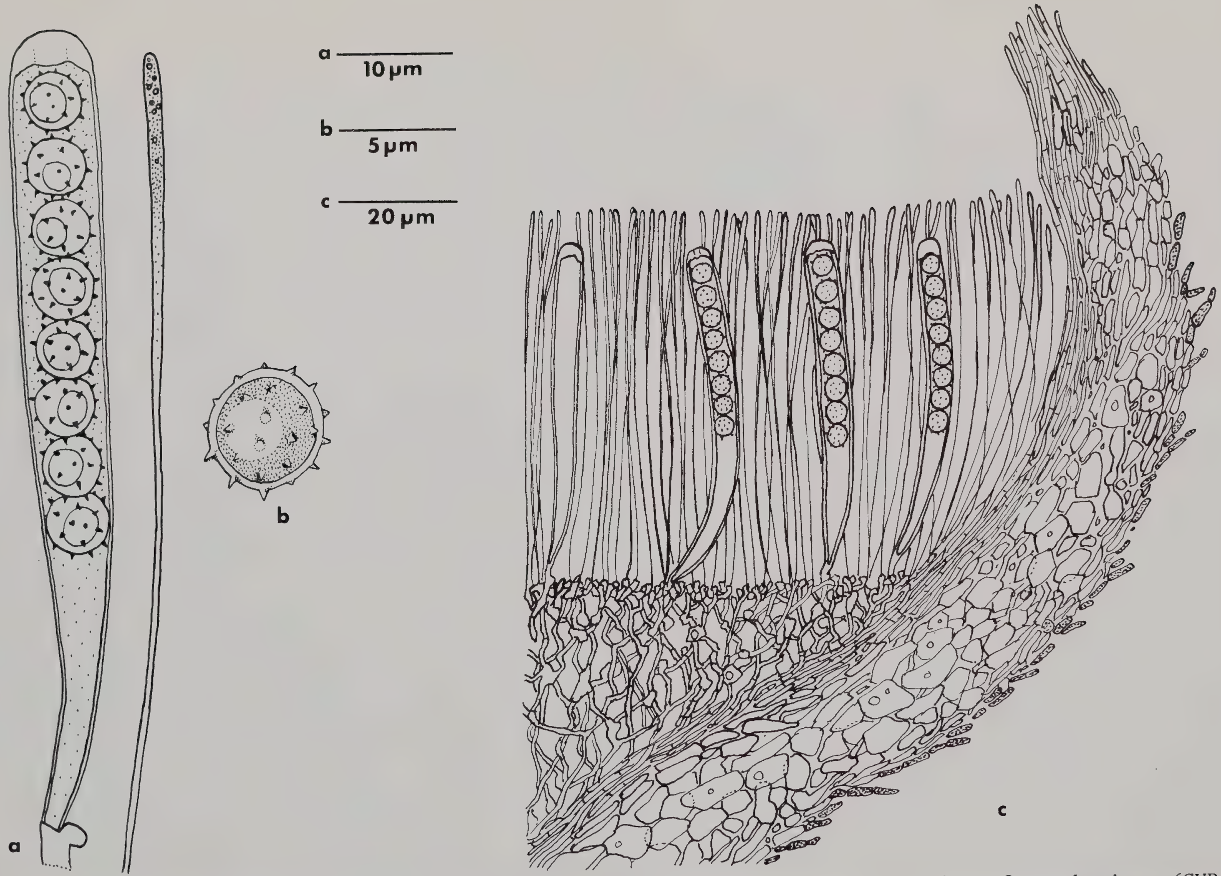

a
10 μm
b
5 μm
c
20 μm
a
b
c

FIG. 1. *Helotiopsis jenkinsii*. a. Ascus and paraphysis. b. Ascospore. c. Cross section of apothecium. (CUP-ME 67.)

with a rather thick apical cap and no obvious preformed pore, J— (whether rehydrated in water or in 2% aqueous KOH). Ascospores 8, uniseriate, globose, colorless, at first smooth, eventually ornamented with coarse spines (? permanently smooth in *H. anonyma*).

KEY TO THE SPECIES

A. Ectal excipulum with short, non-gelatinizing, hairlike projections; apothecia appearing faintly roughened when dry. *H. jenkinsii*

A'. Outermost tissues of ectal excipulum gelatinizing and agglutinated; apothecia smooth when dry.

  B. Hyphae of the ectal excipulum inflated at their tips; walls much narrower than the cell lumen. *H. apicalis*

  B'. Hyphae of the ectal excipulum not enlarged at their tips; walls nearly as thick as the cell lumen. *H. anonyma*

Helotiopsis jenkinsii Sherwood & Korf, *sp. nov.* (FIGS. 1, 2c.)

Apothecia 1 mm in diam. vel minora, breviter stipitata, pallide flava. Cellulae excipuli ectalis globosae, hyphis brevibus brunneis filiformibus interspersis, cellulae excipuli medularis hyphales, laxe intertextae, interdum inflatae. Paraphyses filiformes, supra parum amplificatae, contentu flavescente, granulari. Asci parietibus crassiusculis et apice crassissimo praediti, poro dehiscentes, 65-70 × 5-7 µm, iodo tincto non caerulescentes. Spori sphaerici, achromi, 5.0 µm in diam., spinis grossis ornati. Habitat in radicibus filicum. Holotypus: CUP-ME 67.

Apothecia small, short-stalked, yellowish when dry, ca. 1 mm in diameter, appearing roughened. Excipulum entirely hyphal near the margin, becoming distinctly 3-layered near junction with the stipe. Outer layer of inflated, nearly isodiametric cells with gelatinizing walls, interspersed with 1-2-celled, non-gelatinizing projections; middle layer of parallel, non-gelatinizing hyphae lying at a low angle to the surface; inner layer of vertically oriented, loosely interwoven, irregularly inflated hyphae. Paraphyses simple, septate, 1.5 µm in diameter, scarcely enlarged above. Asci strictly cylindrical, 65-70 × 5-7 µm, when young with an apical cap 3.0 µm thick, this becoming thinner with age.

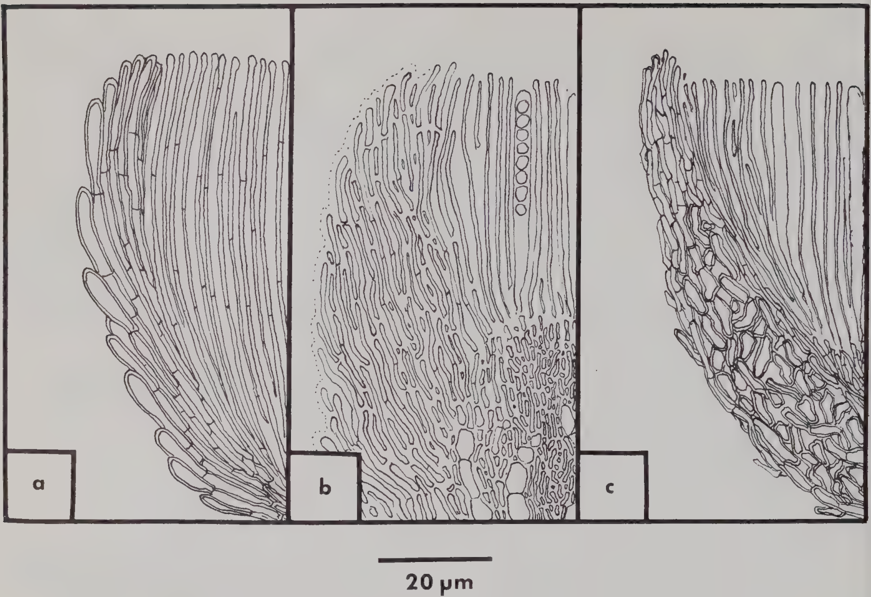


FIG. 2. a. *Helotiopsis apicalis*. (FH-von Höhnel 5395.) b. *H. anonyma*. (S-Rehm 1115b.) c. *H. jenkinsii*. (CUP-ME 67.)

Spores spherical, with coarse, cyanophilic spines, 5.0 µm in diameter (smaller spores seem immature), containing a single large guttule. HOLOTYPE: CUP-ME 67, on fern roots, Salto de Aquiparaba, Guerrero, Mexico, leg. M.B. Spevak, August 29, 1965. PARATYPE: CUP-ME 58, same collection data.

HELOTIOPSIS APICALIS (Berk. & Br.) von Höhnel, Sitzungsber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Cl., Abt. 1, 119: 623. 1910. (FIG. 2a.)

≡ *Peziza apicalis* Berk. & Br., J. Linn. Soc., Bot. 14: 106. 1873.
≡ *Pseudohelotium apicalis* (Berk. & Br.) Sacc., Syll. Fung. 8: 304. 1889.
≡ *Mollisiella apicalis* (Berk. & Br.) Sacc. & Sacc. *in* Sacc., Syll. Fung. 18: 64. 1906.

Apothecia ca. 0.5 mm in diameter, short-stalked, dark yellow, glabrous. Excipulum not distinctly layered above junction with the stipe, consisting of hyphae lying at a low angle to the surface, 2.0-2.5 µm in diameter, with gelatinizing walls, ending in inflated tips 4-7 µm broad. Asci ca. 60 × 6 µm, the apex thickened. Ascospores spherical, 4.0-5.0 µm in diameter, containing a large guttule and ornamented with short spines. On mosses, Ceylon.

SPECIMEN EXAMINED: FH-von Höhnel 5395, *Helotiopsis apicalis*, Orig. on *Rhacomitrium sulcatum*, Ceylon, Thwaites (ISOTYPE).

The above description is based partly on von Höhnel's (*1910*) description and partly on his prepared slides; reactions in cotton blue and in iodine are unknown. Smaller overall size and smaller asci and spores also distinguish this species from *H. jenkinsii*.

Helotiopsis anonyma (Rehm) Sherwood & Korf, *comb. nov.* (FIG. 2b.)

≡ *Pezizella anonyma* Rehm, Hedwigia 34: 165. 1895.
≡ *Mollisiella anonyma* (Rehm) Rehm, Hedwigia 44: 9. 1905.

Apothecia 0.1-0.5 mm in diameter, densely gregarious, subsessile to short-stalked, drying yellow, glabrous. Excipulum unlayered, composed throughout of parallel hyphae with a cell lumen 1.5-2.0 μm wide and thick, gelatinizing walls. Subhymenium containing conspicuous, inflated cells 4.0-6.0 μm in diameter. Asci cylindrical, 45 × 5 μm, the cap 1.0 μm thick and refractive. Ascospores globose, 2.0-3.0 μm in diameter, smooth (at least in youth). Paraphyses filiform, scarcely exceeding the asci, with gelatinizing walls. On stromata of *Valsaria*, Ecuador.

SPECIMENS EXAMINED: S-Rehm, Ascomyceten #1115b, *Pezizella anonyma*, auf dem Stroma von *Valsaria crenata* Rehm an Zweigen einer *Melastoma*, Ecuador, Prov. Pichincha, Prof. V. Lagerheim, 7/1892 (LECTOTYPE, designated here); NY, LECTO-ISOTYPE.

Von Höhnel (*1910*) concluded that this species belonged in *Helotiopsis*, but apparently never made the combination. Many of the apothecia in this collection are immature and lack asci; the species seems, however, to be congeneric, and distinct from the other two.

EXCLUDED SPECIES

HELOTIOPSIS MARGINALIS Vain., Ann. Acad. Sci. Fenn., Ser. A, 15: 151. 1921.

≡ *Bacidia marginalis* (Vain.) R. Sant., Symb. Bot. Upsal. 12: 445. 1954.

According to Santesson (*1952*) this is a foliicolous lichen unrelated to *Helotiopsis*. We accept Santesson's placement of this species.

CONCLUSIONS

Helotiopsis, by virtue of substipitate to stipitate apothecia, hyphal characters of the excipulum, and lack of any obvious stroma is best placed among the Leotiaceae, where its affinities appear to be with *Cyathicula*. The small size and nondescript appearance undoubtedly account for the fragmentary distribution records for this genus. Two of the known species are Neotropical, the other, Paleotropical. All three species occur on cryptogams (fern, moss, Pyrenomycete).

ACKNOWLEDGEMENTS

The authors wish to thank Donald Pfister (Farlow Herbarium, Harvard University) and Rolf Santesson (Naturhistoriska Riksmuseum) for loaning specimens, and William Dress (Bailey Hortorium, Cornell University) for preparing the Latin diagnosis. Steven Carpenter assisted in early phases of the study. The Mexican specimens were acquired under National Science Foundation Grant GB-2339, "Monographic Studies of the Discomycetes," Richard P. Korf, principal investigator.

LITERATURE CITED

HÖHNEL, F. VON. 1910. Fragmente zur Mykologie. 529. *Peziza apicalis* Berk. & Br. Sitzungber. Kaiserl. Akad. Wiss., Math.-Naturwiss. Cl., Abt. 1, 119: 622-623.

O'BRIEN, M. J. 1975. Anna Eliza Jenkins 1886-1972. Mycologia 67: 899-903.

SANTESSON, R. 1952. Foliicolous lichens 1: A revision of the taxonomy of the obligatory foliicolous lichenized fungi. Symb. Bot. Upsal. 12: 1-590.

4
C
92
P 3
-3

MYCOTAXON

AN INTERNATIONAL JOURNAL DESIGNED TO EXPEDITE PUBLICATION
OF RESEARCH ON TAXONOMY & NOMENCLATURE OF FUNGI & LICHENS

Vol. III April-June 1976 No. 3

MAIN LIBRARY ITHACA N.Y. MAY 6 1976

CONTENTS

Hypoxylon grandineum: a loculoascomycete.............. MARGARET E. BARR 325
Notice: Second International Mycological Congress, 1977.............. 330
A new species of *Lactarius* section *Plinthogali* from northeastern North America.. RICHARD L. HOMOLA 331
Trichoderma in Colorado............. F. BRENT REEVES AND CORINNE HORN 337
Synopsis of a new lichen genus, *Everniastrum* Hale (Parmeliaceae) MASON E. HALE, JR. 345
Book Reviews.. G. L. HENNEBERT 354
A new species of *Polychidium* (Lichenes: Peltigeraceae) from New Guinea............................. ANTONIN VEZDA AND WILLIAM A. WEBER 355
Cultural characteristics of *Auriscalpium* and *Gloiodon*. RONALD H. PETERSEN 358
A new species of *Omphalotus*. HOWARD E. BIGELOW, ORSON K. MILLER, JR., AND HARRY D. THIERS 363
Pseudocolus javanicus in Connecticut and its distribution in the United States.. WILLIAM R. BURK 373
Angiopoma Lév., 1841, an earlier name for *Drechslera* Ito, 1930. B. C. SUTTON 377
Lepiota sensu lato in California. II. Type studies of *Lepiota cupressea* and *Lepiota marginata*..................... WALTER J. SUNDBERG 381
A new species of *Eoterfezia* from Mexico and Venezuela. R. S. JENG AND R. F. CAIN 387
A new species of *Ascodesmis* from Venezuela.... R. S. JENG AND R. F. CAIN 391
A nomenclatural note concerning *Sarcinomyces* Lindner and *Sarcinomyces* Oho.. S. C. JONG AND D. S. KING 397
Aciculoconidium: a new hyphomycetous genus to accommodate *Trichosporon aculeatum*..................... D. S. KING AND S. C. JONG 401
Contribution to the knowledge of *Stachybotrys* and *Memnoniella* in culture.. S. C. JONG AND E. E. DAVIS 409
Fungi that decay mesquite in southern Arizona. R. L. GILBERTSON, H. H. ~~BURDSALL,~~ JR., AND E. R. CANFIELD 487
Puciola spinosa, a new dematiaceous hyphomycete from soil. M. DE BERTOLDI 553
Notes on Hyphomycetes. IX. A new species of *Curvularia*. G. MORGAN-JONES AND G. W. KARR, JR. 559
Acaulospora trappei sp. nov...... ROBERT N. AMES AND ROBERT G. LINDERMAN 565
INDEX to Fungous and Lichen Taxa.. 570
Reviewers.. 579
Errata... 580

[MYCOTAXON for January-March 1976 (3: 193-324)
was issued February 6, 1976]

ISSN 0093-4666 MYXNAE 3(3) 325-580 (1976)

Library of Congress Catalogue Card Number 74-7903

Published quarterly by MYCOTAXON, Ltd., P.O. Box 264, Ithaca, NY 14850
For subscription details, see back cover

MYCOTAXON

Vol. III, No. 3, pp. 325-329 April-June 1976

HYPOXYLON GRANDINEUM: A LOCULOASCOMYCETE

MARGARET E. BARR

Department of Botany, University of Massachusetts, Amherst, MA 01002

A fungus which has been accepted as a small aberrant species of *Hypoxylon, H. grandineum* (Berk. & Rav.) Miller (Miller, 1928, 1941, 1961), upon examination proves to be a species belonging to the Loculoascomycetes. This organism produces widely effused reddish brown to blackened areas on fallen trunks of oak (Miller 1961, fig. 118). The aspect is of a thin stroma dotted with protruding apices of small ascocarps. Ascospores (Miller 1961, fig. 146) are similar to those of many species of *Hypoxylon*: one-celled, brown, often apiculate at both ends and with an apparent longitudinal germ slit. The locule differs, however, in the presence of cellular pseudoparaphyses and bitunicate asci.

Very few Loculoascomycetes and members of the Pleosporales especially have one-celled brown ascospores. Some, such as *Auerswaldiella* Theiss. & Syd. have ascospores which become light brown in age. *Auerswaldiella* differs from *Hypoxylon grandineum* in parasitic habit and in the formation of multiloculate ascocarps erumpent from leaf tissue. When the classification of von Arx and Müller (1975) was utilized, *H. grandineum* was sought in the Botryosphaeriaceae. In this family the choices were limited to *Botryosphaeria* and *Guignardia*. Neither genus could be considered acceptable for *H. grandineum* (cf. Barr, 1972). If one emphasizes the presence of germ pores and slit in the ascospores, the family Sporormiaceae is indicated. In this mostly coprophilous family the only genus with one-celled ascospores is *Semidelitschia* Cain & Luck. The sole species, *S. agasmatica* Cain & Luck is coprophilous, has large ascocarps, large ascospores with prominent germ slit, surrounded by a gel sheath. According to Cain and Luck-Allen (1969) "This is the first Loculoascomycete with

1-celled ascospores thus far reported from the temperate region." Certainly this fungus differs markedly from *H. grandineum*. To express the characteristics and relationships of *H. grandineum* a new genus is required.

Loculohypoxylon Barr, gen. nov.

Ascocarpia immersa vel erumpentia, numerosa, effusae vinaceo-brunneae vel atra areae formantes. Asci bitunicati, oblongi vel clavati, quadri- vel octospori, pseudoparaphyses angustae, cellulosae. Ascosporae unicellularis, brunneae, ellipticae vel subglobosae.

Typus generis: *Loculohypoxylon grandineum* (Berk. & Rav.) Barr, comb. nov.

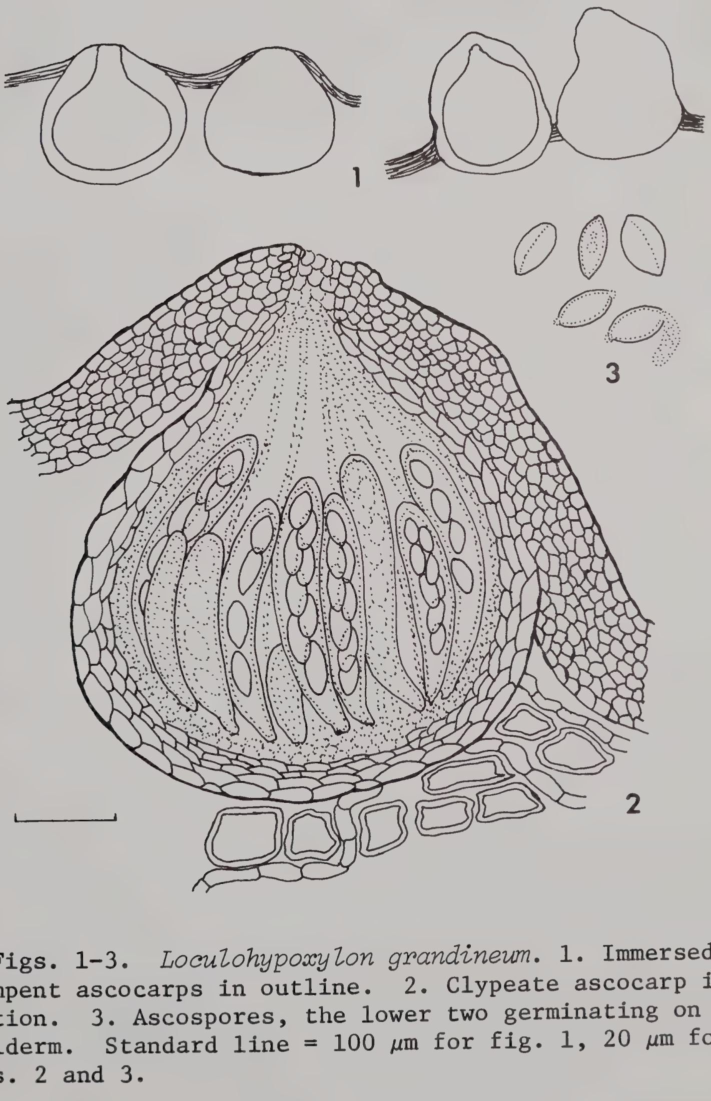
Ascocarps numerous, immersed in inner periderm of host and forming widely effused, reddish brown to blackened patches; ascocarps perithecioid, immersed or widely erumpent, small, frequently darkened and thicker-walled over upper sides as a shallow clypeus, peridium thin and light brown below. Asci bitunicate, oblong or clavate, short stipitate, 4- or 8-spored, arising from base and lower sides of locule, in narrow cellular pseudoparaphyses. Ascospores one-celled, light to dark brown, broadly elliptic or subglobose, symmetric, often apiculate at both ends, apparent germ slit throughout length, wall smooth, overlapping uniseriate or partially biseriate in upper part of ascus.

Loculohypoxylon grandineum (Berk. & Rav.) Barr, comb. nov. Figs. 1-3.

Diatrype grandinea Berk. & Rav. in Berkeley, Grevillea 4: 95. 1876.
Anthostoma grandineum (Berk. & Rav.) Sacc. Syll. Fung. 1: 299. 1882.
Fuckelia grandinea (Berk. & Rav.) Cooke, Grevillea 12: 53. 1883.
Camarops grandinea (Berk. & Rav.) Cooke, Grevillea 13: 108. 1885.
Hypoxylon grandineum (Berk. & Rav.) Miller, Mycologia 33: 74. 1941.

Infected areas widely effused, extending for 15 cm or more, smooth and even or finally rimose, developed beneath

outer layers of host periderm and producing light brown, reddish brown, chocolate brown, and finally blackened color to periderm, exposed with sloughing of outer periderm; ascocarps numerous, in a ± even layer in and erumpent from periderm, globose-depressed with papillate apex when mostly immersed, globose-conic when widely erumpent, (90-)120-160 μm diam; peridium soft, pseudoparenchymatous, slightly



Figs. 1-3. *Loculohypoxylon grandineum*. 1. Immersed and erumpent ascocarps in outline. 2. Clypeate ascocarp in section. 3. Ascospores, the lower two germinating on host periderm. Standard line = 100 μm for fig. 1, 20 μm for figs. 2 and 3.

compressed in side view, reddish brown, 20-25 µm wide in upper part, often extended out from sides as shallow clypeus, light brown, ca. 10 µm wide in lower part; apical pore filled by pallid pseudoparenchymatic mass of cells which gradually gelatinizes, hyphae intercellular in host periderm, light brown near ascocarp base, darkened near surface. Asci 44-70 X 9-11 µm, oblong or clavate, stipe short or elongate, bitunicate, apex nonamyloid, 4- or 8-spored; pseudoparaphyses cellular, narrow. Ascospores 7.5-10(-11) X (4-)5-6.5 µm, light to dark brown, nearly opaque in age, elliptic or subglobose, slightly compressed at times, symmetric, usually with a short hyaline apiculus at both ends, with apparent elongate germ slit, contents 1-2-globulate, wall smooth, uniseriate or partially biseriate in the ascus.

On dead, usually fallen, trunks of *Quercus*.

Material examined: New Jersey: on *Quercus coccinea*, Newfield, Sept 1878, as *Diatrype grandinea*; Ellis N.A.F. 494, (MASS, NY); Newfield, Oct 1881, as *Diatrype grandinea* (NY); Newfield, 29 Nov 1893 as *Anthostoma* (NY); Ellis & Everhart Fungi Col. 324, Newfield, Nov 1893, as *Anthostoma* (NY). South Carolina: Ravenel, Fungi Carol. exs. Fasc. IV: 40, as *Diatrype grandinia* n.sp. (MASS). Georgia: (all as *Hypoxylon grandineum*): *Quercus* sp., Talassie Shoals, 27 Oct 1926, J.H. Miller (GA 2724); Mt. City, 18 Aug 1932, J.H. Miller (GA 2725); Barron Playhouse, Rabun Co., 18 Aug 1932, J.H. Miller (GA unnum.); Athens, J.H. Miller 4467 (GA).

The germ slit visible in the ascospores apparently is nonfunctional. Numerous discharged ascospores are present on the surface of most of the specimens examined, and all of those which had germinated did so by germ tubes from the apiculate tips.

The closest relative of *Loculohypoxylon grandineum* seems to be the genus *Didymosphaeria* Fckl. Both genera have immersed-erumpent small ascocarps, a ± well-developed clypeus around the papillate apex, narrowly cellular pseudoparaphyses, and bitunicate asci with short stipes, containing eight or less ascospores. Species of *Didymosphaeria* have one-septate ascospores, dark brown, with smooth or roughened wall and at times a minute (germ) pore in the tips. The ascospores of *Loculohypoxylon* are similar except that no septum is formed, the wall is smooth, and an apparent germ slit is present. *Loculohypoxylon* and *Didymosphaeria* should be grouped together in the family Didymosphaeriaceae Munk ("ss. restr.", 1957). While Munk also included *Valsaria* Ces. & de Not. in the family, his interpretation of that genus is unacceptable. *Valsaria insitiva* Ces. & de Not. is a member of the Euascomycetes, in the Amphisphaeriaceae of the Xylariales. Other genera of similar ascocarp and locule configuration, whose ascospores are symmetric and brown could be considered also. The sequence of ascospore septations in this small family would be completed by species with several-septate ascospores (e.g. *Passariniella* Berl.) and muriformly-septate ascospores (the Loculoascomycete species presently in *Thyridium* Nits., i.e. *Mycothyridium* Petrak non Müller).

ACKNOWLEDGMENTS

I deeply appreciate the courtesy of the curators of the J. H. Miller Mycological Herbarium (GA) and the New York Botanical Garden (NY), for permission to study collections in their keeping.

LITERATURE CITED

ARX, J.A. VON, and E. MÜLLER. 1975. A re-evaluation of the bitunicate Ascomycetes with keys to families and genera. Studies in Mycology No. 9: 1-159.

BARR, M.E. 1972. Preliminary studies on the Dothideales in temperate North America. Contr. Univ. Michigan Herb. 9: 523-638.

CAIN, R.F., and E.R. LUCK-ALLEN. 1969. *Semidelitschia*, a new genus of the Sporormiaceae. Mycologia 61: 580-585.

MILLER, J.H. 1928. Biologic studies in the Sphaeriales. Mycologia 20: 305-339.

__________. 1941. Georgia Pyrenomycetes. II. Mycologia 33: 74-81.

__________. 1961. A monograph of the world species of *Hypoxylon*. Univ. Georgia Press. 158 p.

MUNK, A. 1957. Danish Pyrenomycetes. Dansk Bot. Ark. 17(1): 1-491.

MYCOTAXON

Vol. III, No. 3, p. 330 April-June 1976

NOTICE

SECOND INTERNATIONAL MYCOLOGICAL CONGRESS 1977

The first circular describing the Second International Mycological Congress has been mailed to interested persons throughout the world. For the purpose of preliminary planning this circular had a December 15, 1975 return date. However, the second circular will not be mailed until the summer of 1976 and there is ample opportunity for all to contribute to the program.

If you have not registered for the second mailing, please contact the Secretary:

Dr. Melvin S. Fuller
Secretary IMC^2
Department of Botany
University of Georgia
Athens, Georgia 30602, USA

imc
2

AUGUST 27 to SEPTEMBER 3, 1977

UNIVERSITY OF SOUTH FLORIDA
TAMPA, FLORIDA

MYCOTAXON

Vol. III, No. 3, pp. 331-336 April-June 1976

A NEW SPECIES OF LACTARIUS SECTION PLINTHOGALI FROM NORTHEASTERN NORTH AMERICA[1]

RICHARD L. HOMOLA

Department of Botany and Plant Pathology
University of Maine
Orono, Maine 04473

SUMMARY

Lactarius louisii is a species of Section *Plinthogali* found in Carbon County, Pennsylvania on very decayed wood, and on *Sphagnum* in wet areas of a woods predominantly of oak and maple. SEM micrographs of the spores and line drawings of details of pilear cuticle, cystidia and spores are presented. The species appears to be most closely related to *L. xanthydrorheus* in stature, watery latex, yellowish distant lamellae, a basal cellular layer in the pilear cuticle, and a yellowish narrow stipe. It differs from *L. xanthydrorheus* in having a white spore deposit, disagreeable taste, and latex not staining or changing to yellow.

Lactarius louisii Homola, sp. nov. *Figs. 1-6*

Pileus 1.7-2.3 cm latus, atrobrunneus vel olivaceus, saepe luteus in medio; contextus cremo colore, fragilis; latex exiguies aquosus, constans; lamellae subdistantes vel distantes, subdecurrentes vel decurrentes, cremo colore; stipes 1.5-3.1 cm longus, 0.3-0.7 cm crassus, concolor cum pileo, fragilis; sporae in cumulo albidae,

---

[1] This work was supported by a grant-in-aid given to the author through a Faculty Research Grant (5-4-26140) administered through Research Funds Committee, University of Maine, Orono, Maine.

6.6-7.7 x 5.1-6.8μ (ornamentatione exclusa) verrucis et cristis usque ad 0.5-0.75μ altis et cinnectivis, ornamentatione reticulum formanti; pileocystidia 16.4-22.4 x 5.1-5.6μ; caulocystidia 22.1-37.5 x 3.0-85μ. Specimen typicum in Herbario University of Michigan, legit R. L. Homola 6276, prope Bowmanstown, Pennsylvania, 30 Aug. 1975.

Pileus (1.6)1.7-2.3(3.5) cm broad, convex with a distinct umbo, expanding to plane or shallowly depressed in center, usually with a conspicuous umbo, dark brown ("Mummy brown") becoming olive brown to olive yellow at maturity ("Isabella color"), often slightly mottled and yellow ("Honey yellow") in center, moist, showing a pruinose effect under a hand lens, distinctly rugose-venose especially in the center, plicate striate, margin crenate and wavy. Context very brittle, thin 0.5-1.5 cm, cream to light yellow ("Cream-buff"), unchanging in contact with air or KOH; odor none; taste unpleasant (bitter, metallic), not acrid. Latex very scanty, watery, unchanging not staining flesh.

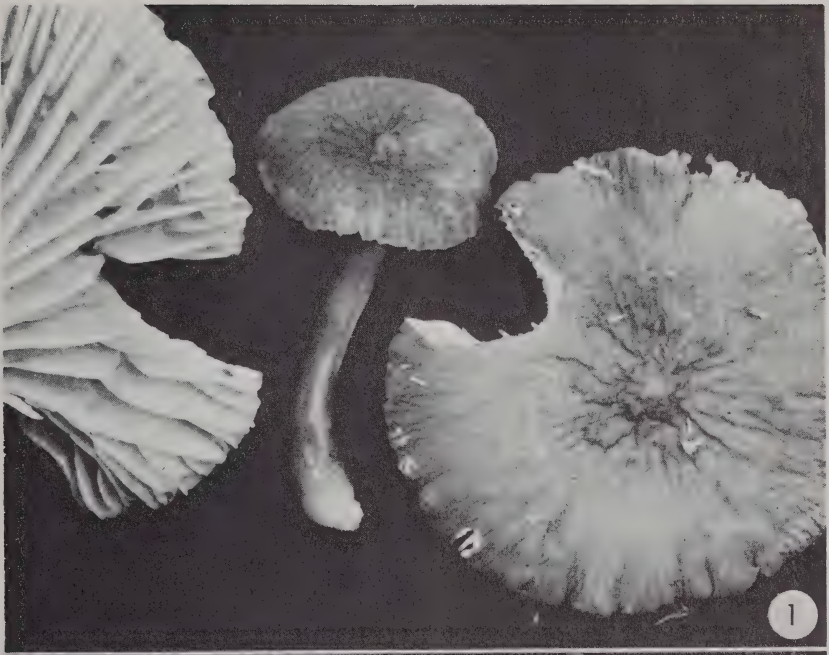
Lamellae adnate to clearly decurrent, cream to yellow ("Cream buff"), subdistant to distant, thick moderately broad 0.15-0.4 cm; lamellulae numerous.

Stipe 1.5-3.1 cm long, 0.3-0.7 cm thick, equal but usually tapered to a pointed base, stuffed becoming hollow, often curved and somewhat twisted, dry, pruinose like pileus under a handlens, apex yellow ("Cream buff", "Honey yellow") becoming dull olive ("Isabella color") to blackish brown ("Mummy brown") toward base, often with white mycelium at base.

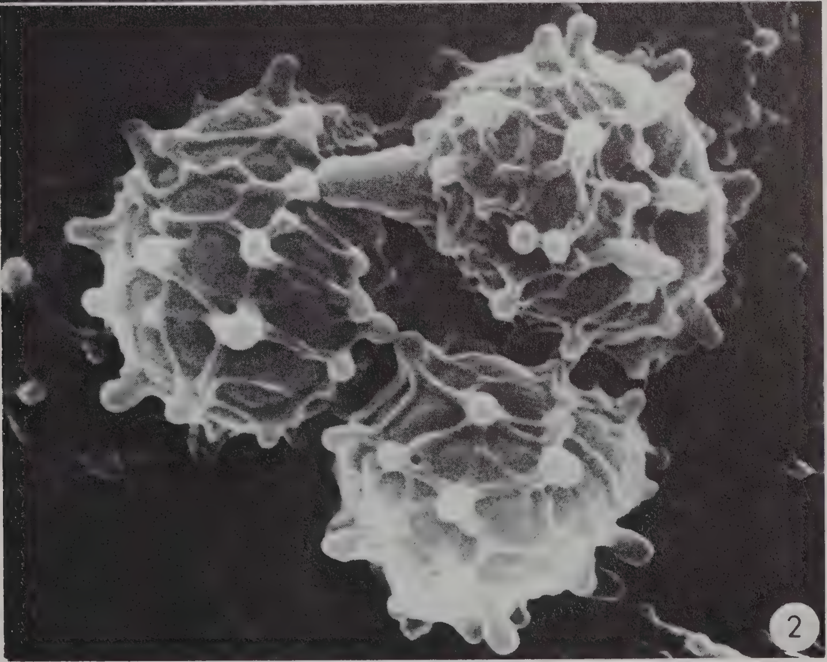
Spore deposit white; spores 6.6-7.7 x 5.1-6.8μ with an occasional giant spore 9.7 x 7.2μ, broadly ovate to subglobose; ornamentation of cylindric to conic warts up to 0.5-0.75μ high, with numerous fine to coarse ridges and connectives, forming a partial to complete reticulum; suprahilar area with low, uneven diffuse ornamentation, amyloid.

Basidia 41.1-46.3 x 7.7-8.7μ, 4-spored, clavate, broadest at or near apex, hyalina to yellowish in KOH with the

Figures 1-2. *Lactarius louisii.* 1. Basidiocarps (*Homola 6276*), x2½. 2. Scanning electron micrograph of spores. (*Homola 5973*), x6516.



①



②

content oily-granular. Pleurocystidia: macrocystidia 42.0-55.1 x 6.1-11.8µ, narrowly cylindric clavate, or fusiform, apex rounded or acute, arising in the subhymenium, projecting, hyaline to pale yellow in KOH with content oily-granular, thin walled, scattered but numerous; pseudocystidia 62.3-73.6 x 6.1-11.8µ, filamentous, flexuous, arising in the trama, embedded or slightly projecting, pale yellowish in KOH with the content oily-granular, thin walled, rare. Cheilocystidia 12.0-25.7 x 5.1-7.2µ, clavate, finger-like to fusoid-ventricose, hyaline, thin-walled, common. Subhymenium prosenchymatous or almost so.

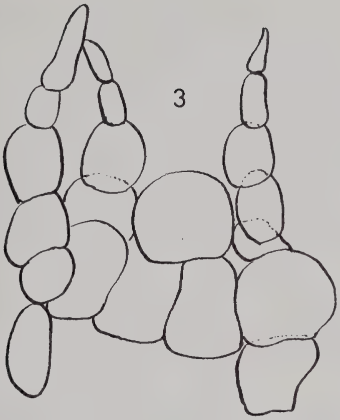
Pileus cuticle 77.2-85.4µ thick, of 3-5 layers of vesiculose to clavate 24.7-37.0 x 16.4-31-9µ cells, often bearing end-cells differentiated as pileocystidia 16.4-22.4 x 5.1-5.6µ, cylindric to clavate to finger-like, occasionally septate, containing brown vacuolar pigment. Lacteriferous hyphae 9.2-14.4µ broad, hyaline to pale yellow in KOH, with oily content, often with pores which appear operculate, rather common. Pileus trama heteromerous. Caulocystidia 22.1-37.5 x 3.0-8.5µ, clavate to cylindric to filamentous, clustered and forming a turf of cells containing a brown vacuolar pigment, of 1-3 lavers. basal cells rectangular to broadly clavate which are attached to prostrate hyphae.

Scattered to gregarious on buried wood or among *Sphagnum* in wet areas of a deciduous woods which are predominately oak and maple.

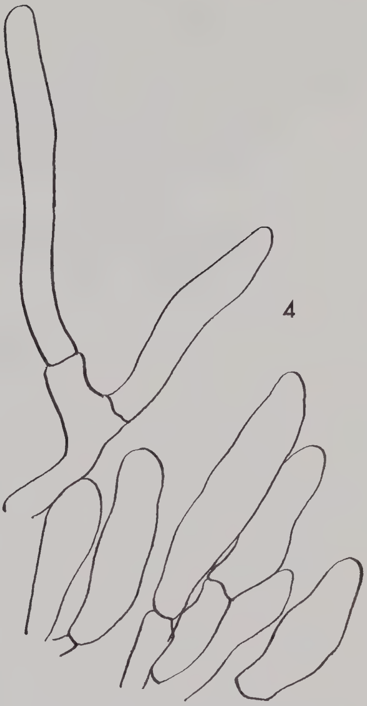
Collections: Pennsylvania: Carbon Co., near Bowmanstown, Aug. 27, 1974, *Homola 5973* (parts of collection MICH & MAINE) *Homola 6003* (MAINE), Aug. 30, 1975, *Homola 6276* (holotype of *Lactarius louisii*, MICH).

Among the species of section *Plinthogali*, *Lactarius louisii* is distinguished by the following set or characters: a small, fragile brown to yellow basidiocarp; scanty watery latex; bitter tasting flesh, thick cream colored, subdistant decurrent lamellae; a fragile partially yellow

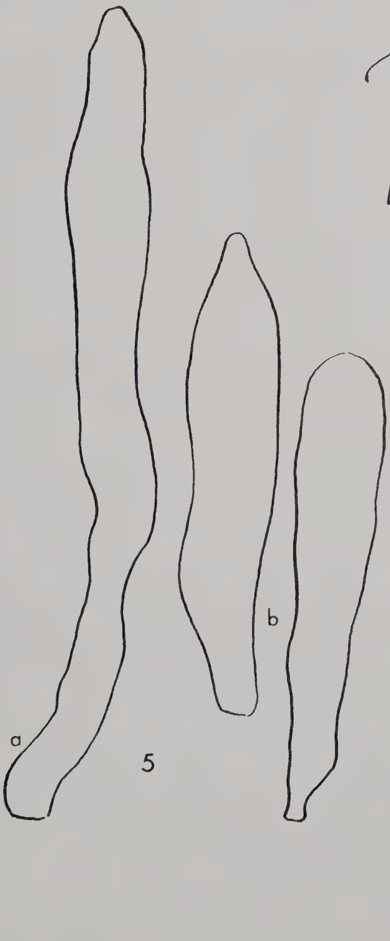
Figures 3-6. *Lactarius louisii, (Homola 6276).* 3. Pileus cutis, x460. 4. Hyphal ends from stipe surface, x1140. 5. Hymenial cystidia; a. pseudocystidium ; b. macrocystida, x1140. 6. Spores, x1481.



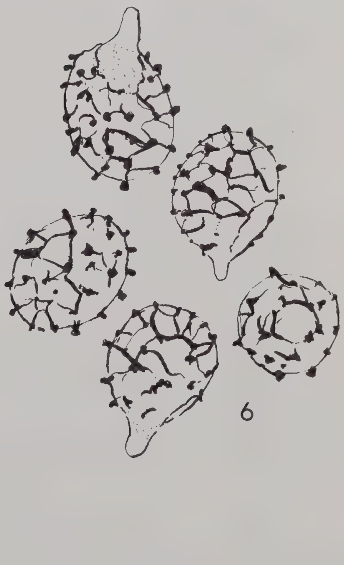
3



4



5



6

stipe; white spores with moderate high wart-like prominences as part of the ornamentation but under the SEM showing a fairly complete reticulum; and the epithelial type of pileus cuticle. The species differs from *L. xanthydrorheus* Sing. (1945) in having a white spore deposit, disagreeable taste, and in not having the latex change to yellow on exposure to air. In section *Plinthogali*, *L. louisii* differs from *L. gerardii* Pk. in having a much smaller basidiocarp, smaller differently ornamented spores, and a watery latex (Smith and Hesler, 1962).

ACKNOWLEDGMENT

I wish to thank A. H. Smith for reading the manuscript and checking out the species in the unpublished manuscript of Hesler and Smith on North American Species of *Lactarius*. I also wish to thank Professor David Tatem of the Department of Foreign Languages and Classics, University of Maine, Orono, for his help in writing the Latin description.

LITERATURE CITED

Singer, R. 1945. New and Interesting Species of Basidiomycetes. *Mycologia* 37: 425-439.

Smith, A. H. and L. R. Hesler. 1962. Studies on *Lactarius*-III. The North American Species of Section *Plinthogali*. *Brittonia* 14: 369-440.

MYCOTAXON

Vol. III, No. 3, pp. 337-344 April-June 1976

TRICHODERMA IN COLORADO

F. BRENT REEVES AND CORINNE HORN

Botany and Plant Pathology Department
Colorado State University
Fort Collins, Colorado 80523

SUMMARY

Seven of the ten species aggregates of *Trichoderma* are found in Colorado. The most common species are *T. harzianum, T. aureoviride, T. viride,* and *T. koningii.* There is no obvious correlation of altitude and species distributions in this genus. In addition to the *Trichoderma* species, a list of fungi reportedly isolated from Colorado soils is included. This list, including the *Trichoderma* species, contains 97 taxa.

A compilation of the reports of fungi isolated from Colorado soils indicates that 97 taxa have been reported (1,7,8,9,10,12,14,15). In each of these reports *Trichoderma* is an important and frequently occurring genus. However, most of the identifications in these reports were made prior to Rifai's (11) monograph. Because of the confusion of disposition of species (species aggregates) (4,11) in this genus we began a study of the common Trichodermas found in Colorado soils with a special effort directed towards determining if there were any correlation between elevation and distribution of the species aggregates.

In this report we list the fungi isolated from Colorado soils and treat the *Trichoderma* isolates according to Rifai (11). Of the ten common species of this genus reported from the soil (5,11), seven occur in Colorado.

MATERIALS AND METHODS

Soil samples were collected in June, July, and August of 1974 at the sites given in Table I. The top three cm of soil were removed with a sterile vial; surface debris was not included unless it had been incorporated into the mineral portion of the soil. The samples were transported to the lab at air temperature and immediately processed for isolation studies.

The dilution plate technique was used for isolation. One ml of a 1:50 dilution was pipetted onto the surface of potato dextrose agar (PDA) containing antibiotics (Penicillin G and Streptomycin) in 100 mm Petri plates and incubated at room temperature (23°C). From each soil sample five plates were made. From *Trichoderma*-like colonies subcultures were established on 2% malt agar plates for identification (11).

All nomenclature is given as it first appears in the original literature cited with equivalents in parentheses according to recent treatments cited in Domsch and Gams (4), Kendrick and Carmichael (6), or Sutton (13).

RESULTS AND DISCUSSION

Two species of *Trichoderma* previously reported from Colorado (see list of soil fungi reportedly isolated from Colorado) are now disposed in several species aggregates, viz. *T. lignorum* in *T. harzianum* and *T. viride*, and *T. glaucum* in *T. aureoviride* and *T. viride*, and the other two species are questionably disposed (11).

The concept of the species of *Trichoderma* has been so confused by different authors that it has been impossible to assign the species previously reported from Colorado to any of those proposed by Rifai (11). Our investigation reveals the following taxa, as defined by Rifai (11): *Trichoderma aureoviride* Rifai aggr., *T. hamatum* (Bon.) Bain., *T. harzianum* Rifai aggr., *T. koningii* Oud., *T. polysporum* (Link ex Pers.) Rifai aggr., *T. pseudokoningii* Rifai aggr., and *T. viride* Pers. ex S. F. Gray.

The sites, elevations and species of *Trichoderma* collected are given in Table I. Figure 1 shows the

TABLE I

Locality, elevation, and *Trichoderma* species present

COLLECTION SITE	ELEVATION (M)	TRICHODERMA SPECIES
16 Sterling Reservoir	1212	harzianum, hamatum
15 Sterling	1250	---
14 Fort Morgan	1280	harzianum, aureoviride
13 Greeley	1402	pseudokoningii, hamatum
4 Horsetooth Res.	1585	harzianum, aureoviride
10 Lyons	1951	harzianum, koningii
5 Colorado Springs	2195	harzianum, koningii, viride
2 Black Canyon	2621	aureoviride, koningii, viride
17 Idaho Springs	2804	harzianum, viride
12 White River Nat'l. Forest	2865	viride, pseudokoningii, koningii
9 Frazier	2896	harzianum, viride, pseudokoningii
7 Cripple Creek	2972	harzianum, aureoviride, viride
6 Gold Camp Road	2987	viride, koningii, pseudokoningii
3 Leadville	3109	harzianum, aureoviride, polysporum, viride
18 Loveland Pass	3109	harzianum
11 White River Nat'l. Forest	3200	viride, aureoviride
8 Berthoud Pass	3444	harzianum, viride
1 Monarch Pass	3448	harzianum, aureoviride

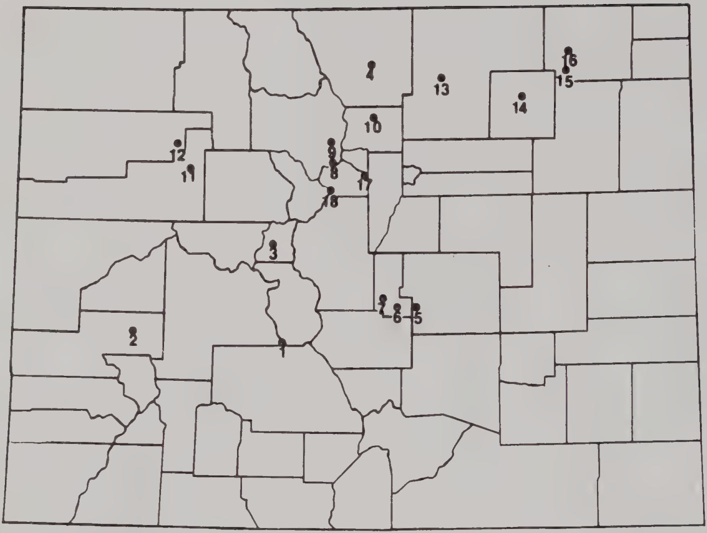

16
15
13
14
4
10
12
11
9
8
17
18
3
7
6
5
2
1

Figure 1. Collection sites in Colorado.

Site	Elev.	harz.	aureov.	koningii	viride	polys.	hamatum	pseudok.
1	3448	+	+	-	-	-	-	-
8	3444	+	-	-	+	-	-	-
11	3200	-	+	-	+	-	-	-
18	3109	+	-	-	-	-	-	-
3	3109	+	+	-	+	+	-	-
6	2987	-	-	+	+	-	-	+
7	2972	+	+	-	+	-	-	-
9	2896	+	-	-	+	-	-	+
12	2865	-	-	+	+	-	-	+
17	2804	+	-	-	+	-	-	-
2	2621	-	+	+	+	-	-	-
5	2195	+	-	+	+	-	-	-
10	1951	+	-	+	-	-	-	-
4	1585	+	+	-	-	-	-	-
13	1402	-	-	-	-	-	+	+
14	1280	+	+	-	-	-	-	-
15	1250	-	-	-	-	-	-	-
16	1212	+	-	-	-	-	+	-

Figure 2. Elevation vs. *Trichoderma* species present.

location of the collection sites in Colorado; note that both sides of the Continental Divide were sampled. Figure 2 illustrates the *Trichoderma* species isolated at each elevation; note that only Site 15 had no demonstrative *Trichoderma* isolates. When this site was sampled the air temperature was 32°C (90°F) and the soil temperature was very hot. Perhaps the heat killed the *Trichoderma* species at this site.

In a series of papers Dennis and Webster (2,3) have shown that *Trichoderma* species produce both non-volatile and volatile antibiotics against various test fungi; however, antibiotic production is variable within each species group. Based on very limited data we have found that *T. harzianum* and *T. koningii* grow most rapidly and *T. pseudokoningii* and *T. polysporum* grow most slowly. No doubt both variable antibiotic-production and variable growth-rate among the species are very important in the recovery of *Trichoderma* species from the soil plates. However, other factors must also be important because *T. aureoviride*, recovered at most elevations (Table I), is neither among the most rapid growers nor most efficient antibiotic producers. Only further ecological studies can determine the relationships among the soils and these fungi.

We initially expected to find a definite distribution of *Trichoderma* species based on altitude. No such distribution is obvious. In fact we suspect that if enough soil samples are screened one can probably find most of the species of *Trichoderma* at each elevation. At those elevations for which we have the greatest number of samples, viz. 2865-3109 M, Sites 12,9,7,6,3,18, six of the seven species are found. The apparent absence of *T. piluliferum* Webster & Rifai, *T. longibrachiatum* Rifai, and *T. saturnisporum* Hammill may be explained by their inability to compete in the soil plates or their actual absence. The latter is probably the best explanation since Dennis and Webster (2,3) report that both *T. piluliferum* and *T. longibrachiatum* produce non-volatile antibiotics and Rifai (11) notes that *T. longibrachiatum* grows very rapidly.

Previous studies have reported the following Colorado soil fungi: *Absidia spinosa* Lendner (9); *Acrothecium robustum* Gilman & Abbott (9); *Actinomuçor repens* Schost. (=*A. elegans* (Eidam) Benj. & Hesselt.) (7); *Alternaria* spp.

(9,15); *Alternaria tenuis* Nees (=*A. alternata* (Fr.) Keissl.) (1,12); *Arthrinium arundinis* (Corda) Fr. (1,12); *Aspergillus* spp. (1,12); *Aspergillus candidus* group (8); *Aspergillus clavatus* Desm. (9); *A. flavus* Link ex Fr. (8,9); *A. fumigatus* Fres. (1,9,12); *A. glaucus* Link (=*A. glaucus* group) (9,10); *A. minutus* Abbott (=*A. ustus* (Bainier) Thom & Church) (8,9); *A. niger* V. Tieg. (9,10); *A. ochraceous* Wilhelm (8); *A. quadrilineatus* Thom & Raper (14); *A. terreus* Thom (1,8,9,12); *A. wentii* Wehmer (8,9); *Beauveria bassiana* (Bals.) Vuill. (1,12); *Cephalosporium* spp. (= ? *Acremonium* spp.) (1,7,10,12); *Cephalosporium curtipes* Sacc. (15); *Cladosporium cladosporioides* (Fres.) de Vries (1,12); *Coniothryrium* sp. (1,12); *Cunninghamella verticillata* Paine (8,9); *Dicoccum asperum* (Corda) Lindau (=*Trichocladium asperum* Harx.) (15); *Diplodia* sp. (1,12); *Discosia* sp. (1,12); *Fusarium* spp. (9,10); *Fusarium caudatum* Wollenw. (=*F. equiseti* (Corda) Sacc.) (11); *F. moniliforme* Sheld. (1,7,12); *F. nivale* (Fr.) Ces. (1,12); *F. oxysporum* Schlecht. emend Snyder & Hansen (7,15); *F. roseum* (Lk.) Sacc. (=*Fusarium* sp. aggr.) (1,7,12); *F. solani* (Mart.) Sacc. (1,7,12,15); *F. tricinctum* (Corda) Sacc. (7); *Gliobotrys alboviridis* Hohnel (=*Stachybotrys subsimplex* Cooke (9); *Helminthosporium* spp. (15); *H. anomalum* Gilman & Abbott (1,12); *H. sativum* Pammel, King & Bakke (=*Drechslera* state of *Cochliobolus sativus* (Ito & Kuribayashi) Drechsler ex Dastur) (7); *Hormiscium* spp. (=*Torula* spp.) (1,12); *Hormodendrum cladosporioides* Fres.) Sacc. (=*Cladosporium cladosporioides* (Fres.) de Vries) (8,9); *H. pallidum* Oud. (=*Cladosporium*) (10); ?*Idriella lunata* Nelson & Wilhelm (1,12); *Macrosporium* sp. (10); *Mucor circinelloides* van Tieg. (15); *M. glomerula* Lender (8,9); *M. lausannensis* Lender (8,9); *M. racemosus* Fres. (15); *Mortierrella* spp. (7); *Papulospora* spp. (1,12); *Penicillium* spp. (10); *P. adametzi* Zaleski (1,12); *P. chrysogenum* Thom (8,9,10,15); *P. citrinum* Thom (8,9); *P. commune* Thom (8); *P. decumbens* Thom (15); *P. digitatum* Sacc. (8,9); *P. duclauxi* Delacroix (10); *P. echinatum* Dale (=*P. nigricans* (Bain.) Thom) (9); *P. expansum* Link (8,9,10); *P. funiculosum* Thom (1,10,12); *P. humicola* Oud. (=species of uncertain position) (8,9); *P. intricatum* Thom (=*P. godlewskii* Zaleski) (10); *P. janthinellum* series (1,12); *P. janthinellum* Biourge (1,12); *P. lilacinum* Thom (1,10,12); *P. piceum* Raper & Fennell (1,12); *P. purpurogenum* Stoll (8,9); *P. restrictum* Gilman & Abbott (1,12); *P. roseum* Link (=*Gliocladium roseum* Bainier) (10); *P. stoloniferum* Thom (8,9); *P. viridicatum* Westling (8,9); *Peyronellaea* sp. (1,12); *Phoma* spp. (9); *Phoma betae* Frank

(7); *Phytophthora* spp. (7); *Pullularia pullulans* (deBary) Berkhout (=*Aureobasidium pullulans* (deBary) Arn.) (1,12); *Pyrenochaeta* sp. (1,12); *P. terrestre* (Hansen) Gorenz, Walker & Larson (7); *Pythium* spp. (7); *Rhizoctonia solani* Kuhn (7); *Rhizopus arrhizus* Fischer (8); *R. elegans* Eidam (=*Actinomucor repens* Schost.) (8,9); *R. nigricans* (=*R. stolonifer* (Fr.) Linder) (8,9,10); *Sepedonium chrysospermum* (Pers.) Fr. (9); *Sphaeropsis* sp. (1,12); *Spicaria simplicissima* Oud. (=*Penicillium simplicissimum* (Oud.) Thom) (10); *Sporotrichum pruinosum* Gilman & Abbott (=*Chrysosporium pruinosum* (Gil. & Abb.) Carmichael) (8); *Stachybotrys cylindrospora* Jensen (10); *Stemphylium* sp. (1,12); *Syncephalastrum racemosum* (Cohn) Schroet. (1,12); *Trichoderma album* Preuss. (?=*Trichoderma polysporum* (Link ex Pers.) Rifai (1,12); *T. glaucum* Abb. (?=*T. viride* Pers. ex Fr.) (10); *T. lignorum* (Tode) Harz. (=*T. viride* Pers. ex Fr.) (8,9,10); *T. viride* Pers. ex Fr. (1,7,12); *Trichothecium roseum* Link (8); and *Verticillium terrestre* (Link) Lindau (=*Costantinella terrestris* (Link) Hughes) (10).

As indicated in almost all of the reports of soil fungi from Colorado (1,7,8,9,10,12,15) *Trichoderma* is one of the most important genera found. This report confirms previous reports and demonstrates that the genus is well represented with most of the known species occurring in the state.

LITERATURE CITED

1. CHRISTENSEN, MARTHA, and ARLA M. SCARBOROUGH. 1969. Soil microfungi investigations, Pawnee site. Technical Report 23. Grasslands Biome. U.S. International Biological Program. Natural Resource Ecology Laboratory. Colorado State University. Fort Collins, Colorado.

2. DENNIS, C., and J. WEBSTER. 1971. Antagonistic properties of species-groups of Trichoderma. I. Production of non-volatile antibiotics. Trans. Brit. Mycol. Soc. 57: 25-39.

3. DENNIS, C., and J. WEBSTER. 1971. Antagonistic properties of species-groups of Trichoderma. II. Production of volatile antibiotics. Trans. Brit. Mycol. Soc. 57: 41-48.

4. DOMSCH, K. H., and W. GAMS. 1972. Fungi in Agricultural Soils. Halsted Press Div. John Wiley & Sons, Inc., New York. 290 p.

5. HAMMILL, T. M. 1970. *Paecilomyces clavisporis* sp. nov., and other noteworthy soil fungi from Georgia. Mycologia 62: 107-122.

6. KENDRICK, W. B., and J. W. CARMICHAEL. 1973. Hyphomycetes, pp. 323-509. *In* G. C. AINSWORTH, F. K. SPARROW, and A. S. SUSSMAN (eds.), The Fungi, An Advanced Treatise. IV A. Academic Press, New York.

7. KREUTZER, W. A. 1972. *Fusarium* spp. as colonists and potential pathogens in root zones of grassland plants. Phytopathology 62: 1066-1070.

8. LECLERG, E. L. 1930. Cultural studies of some soil fungi. Mycologia 22: 186-210.

9. ______. 1931. Distribution of certain fungi in Colorado soils. Phytopathology 21: 1073-1081.

10. ______, and F. B. SMITH. 1928. Fungi in some Colorado soils. Soil Sci. 25: 433-441.

11. RIFAI, M. 1969. A Revision of the Genus *Trichoderma*. Mycological Papers 116. 56 p. Commonwealth Mycological Institute, Kew, Surrey, England.

12. SCARBOROUGH, ARLA M. 1970. The soil microfungi of a Colorado grassland. M.S. Thesis, University of Wyoming, Laramie. 68 p.

13. SUTTON, B. C. 1973. Coelomycetes, pp. 513-582. *In* G. C. AINSWORTH, F. K. SPARROW, and A. S. SUSSMAN (eds.), The Fungi, An Advance Treatise, IV A. Academic Press, New York.

14. THOM, C., and K. B. RAPER. 1939. The *Aspergillus nidulans* group. Mycologia 31: 653-669.

15. WAKSMAN, S. A. 1917. Is there any fungus flora in the soil? Soil Sci. 3: 565-589.

MYCOTAXON

Vol. III, No. 3, pp. 345-353 April-June 1976

SYNOPSIS OF A NEW LICHEN GENUS, *EVERNIASTRUM* Hale (Parmeliaceae)

Mason E. Hale, Jr.
Department of Botany, Smithsonian Institution
Washington, D.C. 20560

SUMMARY

The presently recognized species of *Parmelia* subgenus *Everniiformes* (Hue) Hale & M. Wirth are transferred to the new genus *Everniastrum* Hale and three additional species are described, *E. africanum* Hale, *E. peruvianum* Hale, and *E. subnepalense* Hale.

EVERNIASTRUM Hale, nom. et genus nov.

Parmelia section *Everniiformes* Hue, Jour. de Bot. 12:180. 1898.
Parmelia subgenus *Everniiformes* (Hue) Hale & M. Wirth, Phytologia 22:36. 1971.

Lectotype species: *Parmelia cirrhata* E. Fries, Syst. Orb. Veg. 1:283. 1825 (= *Everniastrum cirrhatum* (E. Fries) Hale).

The genus *Everniastrum* includes those species formerly classified in *Parmelia* subgenus *Everniiformis*. It is characterized by long, linear, subcanaliculate to involute lobes with or without long marginal cilia and rhizines (see Figures 1-4). It has a pored epicortex and a generally palisade-like upper cortex (Hale, 1973). The chemistry is not varied, all species having atranorin in the cortex and nearly half salazinic acid in the medulla, often accompanied by protolichesterinic acid, a fatty acid. Alectoronic acid, constictic acid, fumarprotocetraric acid, gyrophoric acid, norstictic acid, and protocetraric acid have also been reported (Hale & Wirth, 1971).

Everniastrum occurs primarily in the high mountains of tropical America from Mexico and the West Indies to Chile and southern Brazil and Argentina. Only four of the 21 species in the genus, *E. cirrhatum*, *E. nepalense*, *E. sorocheilum*, and *E. vexans*, occur in Asia. No species are known at the present time from Europe or North Africa, and the genus is only sparsely represented in south-central Africa. The center of speciation is the pine-covered highlands of Mexico, where 12 species have been collected, and the Andean region in Peru.

Everniastrum bears considerable superficial resemblance to *Pseudevernia* Zopf (Hale, 1968), which also has divaricate, canaliculate lobes but lacks rhizines completely and, more significantly, lacks an epicortex (Hale, 1973). *Evernia*, too, is similar, but this usneoid genus contains usnic acid in the cortex and lacks an epicortex. Some species of *Hypotrachyna* (Vainio) Hale have long linear lobes but these are not canaliculate and dichotomously branched rhizines are always present (Hale, 1975).

The following 21 species are recognized in the genus. Certain complex South American and African populations have not yet been worked out, but relatively few undescribed species remain.

Everniastrum africanum Hale, sp. nov.

Thallus (Figure 1) adnatus, corticola, albo-cinereus, 6-8 cm latus, lobis lineari-elongatis, subcanaliculatis, 1.5-2.5 mm latis, margine rhizinatis, rhizinis dichotome ramosis, usque ad 2 mm longis, superne continuus, nitidus, emaculatus, sorediis isidiisque destitutus, subtus niger, nudus vel pro parte rhizinosus, rhizinis dichotome ramosis. Apothecia sparsa, sessilia, 2 mm diametro, sporis octonis, 6 X 9-12 µm.

Chemistry: Cortex K+ yellow, medulla K-, C-, KC+ reddish, P+ deep yellow, atranorin, alectoronic acid and echinocarpic acid.

Holotype: Subalpine elfin forest, Lukwangule Plateau, Uluguru Mountain, Morogoro District, Tanzania, elev. 2400 m, T. Pócs and P. & K. Csontos 6082/H, 8 Dec. 1969 (BM; isotype in US).

This species is not closely related to any other in the genus. The lobes are quite flat and broad. The most unusual feature, however, is the chemistry, a previously unreported combination of two acids, alectoronic acid and echinocarpic acid, neither of which was known before in *Everniastrum*.

Everniastrum americanum (Meyen & Flot.) Hale, comb. nov. Basionym: *Evernia americana* Meyen & Flot. Nov. Acta Caes. Leop. Carol. Suppl. 1, 19:211. 1843.

The identity of the often misapplied epithet has been established with an isotype at Geneva from Tinguirica River, Chile. It is densely marginally tufted-ciliate, nonisidiate, and more or less bare below (Figure 2), containing protolichesterinic acid and restricted to Chile. Nylander (Ann. Sci. Nat. ser. 4, 11:215. 1859) seems to be the first lichenologist to have taken up the name in the wrong sense, as a variety of "Parmelia camtschadalis", which is actually *Xanthoparmelia camtschadalis* (Ach.) Hale, an unrelated species. Vainio (Hedw. 38:(123). 1899) considered "Parmelia americana" to have isidia, and in general isidiate specimens from tropical America have been rather consistently identified as such. Most of them, however, must be redetermined as *E. vexans* (Zahlbr.) Hale.

Everniastrum arsenei (Hale & M. Wirth) Hale, comb. nov. Basionym: *Parmelia arsenei* Hale & M. Wirth, Phytologia 22:40. 1971.

Everniastrum catawbiense (Degelius) Hale, comb. nov. Basionym: *Parmelia sorocheila* var. *catawbiensis* Degelius, Ark. f. Bot. 30A(3):65. 1941.

Everniastrum cirrhatum (E. Fries) Hale, comb. nov. Basionym: *Parmelia cirrhata* E. Fries, Syst. Orb. Veg. 1:283. 1825.

Everniastrum columbiense (Zahlbr.) Hale, comb. nov. Basionym: *Parmelia columbiensis* Zahlbr. Cat. Lich. Univ. 6:61. 1929.

Everniastrum ecuadoriense (R. Sant.) Hale, comb. nov. Basionym: *Parmelia ecuadoriensis* R. Sant. Bot. Not. 1942: 328. 1942.

Everniastrum fistulatum (Taylor) Hale, comb. nov. Basionym: *Parmelia fistulata* Taylor, Lond. Jour. Bot. 6:168. 1847.

Everniastrum imitatum (Hale & M. Wirth) Hale, comb. nov. Basionym: *Parmelia imitata* Hale & Wirth, Phytologia 22:38. 1971.

Everniastrum limaeforme (Taylor) Hale, comb. nov. Basionym: *Parmelia limaeformis* Taylor, Lond. Jour. Bot. 6:170. 1847.

Everniastrum lipidiferum (Hale & M. Wirth) Hale, comb. nov. Basionym: *Parmelia lipidifera* Hale & M. Wirth, Phytologia 22:37. 1971.

Everniastrum moreliense (Bouly de Lesd.) Hale, comb. nov. Basionym: *Parmelia moreliensis* Bouly de Lesd. Lich. Mex. 5. 1914.

Everniastrum neocirrhatum (Hale & M. Wirth) Hale, comb. nov. Basionym: *Parmelia neocirrhata* Hale & M. Wirth, Phytologia 22:37. 1971.

Everniastrum nepalense (Taylor) Hale, comb. nov. Basionym: *Parmelia nepalensis* Taylor, Lond. Jour. Bot. 6:172. 1847.

Everniastrum nigrociliatum (Bouly de Lesd.) Hale, comb. nov. Basionym: *Parmelia nigrociliata* Bouly de Lesd. Ann. Crypt. Exot. 6:117. 1933.

Everniastrum pachydermum (Hue) Hale, comb. nov. Basionym: *Parmelia pachyderma* Hue, Nouv. Arch. Mus. Paris, ser. 4, 1:137. 1899.

Everniastrum peruvianum Hale, sp. nov.

Thallus (Figure 3) laxe adnatus, suberectus, ramulicola, cinereo-albus, 8-12 cm latus, lobis lineari-elongatis, divaricatis, canaliculatis vel involutis, 1.5-2 mm latis, margine sparse vel modice ciliato-rhizinosis, ciliis usque ad 3 mm longis, simplicibus vel furcatis, superne nitidus, leviter albo-maculatus, isidiis sorediisque destitutus, subtus niger vel apicem versus pallide castaneus, nudus. Apothecia numerosa, subterminalia, 5-8 mm diametro, amphithecio rugoso, sporis octonis, 6-8 X 14-18 µm.

Chemistry: Cortex K+ yellow, medulla K+ yellow, C-, KC-, P+ orange, atranorin and constictic acid.

Holotype: Cloud forest remnants, base of Huayna Picchu, Prov. Urubamba, Dept. Cuzco, Peru, elev. 2500 m, H. H. & C. M. Iltis 3020, 3 January 1973 (US; isotypes in UPS, WIS).

Additional specimens examined: Same locality as the holotype, H. H. & C. M. Iltis 3148, 3170 (US, WIS).

This species would probably be identified as *E. cirrhatum* if no chemical test were made. *Everniastrum cirrhatum* contains salazinic acid and in general has a more fragile thallus without conspicuous white maculation. Constictic acid usually occurs with stictic acid. Outside of this report, it has been found alone only in *Usnea* (Asahina, 1968).

Everniastrum pseudonepalense (Hale & M. Wirth) Hale, comb. nov. Basionym: *Parmelia pseudonepalensis* Hale & M. Wirth, Phytologia 22:40. 1971.

Everniastrum sorocheilum (Vainio) Hale, comb. nov. Basionym: *Parmelia sorocheila* Vainio, Hedw. 38:(123). 1899.

Everniastrum subnepalense Hale, sp. nov.

Thallus (Figure 4) laxe adnatus, corticola, cinereoalbus, 8-10 cm latus, lobis lineari-elongatis, divaricatis, modice involutis, 1-2 mm latis, margine sparse ciliatorhizinosis, ciliis ca. 1 mm longis, superne nitidus, valde albo-maculatus, isidiis sorediisque destitutus, subtus niger, apicem versus castaneus, dense rhizinosus, rhizinis sparse dichotome furcatis, ca. 0.5 mm longis. Apothecia desunt.

Chemistry: Cortex K+ yellow, medulla K-, C-, KC-, P+ red, atranorin and fumarprotocetraric acid.

Holotype: 5½ Km below San Pablo on road to Chilete, Dept. Cajamarca, Peru, elev. 2080 m, P. C. Hutchinson and J. K. Wright 5088 (US; isotypes in UC and UPS).

Additional specimens examined: Prov. Cajatamba, Peru, elev. 2700 m, Sandeman 5307 (BM, US).

This species resembles *E. nepalense* superficially in having rhizines below, but the lobes are not as flattened and the thallus is smaller and more fragile. The chemistry is unique, this being the first report of fumarprotocetraric acid in the everniiform group.

Everniastrum vexans (Zahlbr.) Hale, comb. nov. Basionym: *Parmelia vexans* Zahlbr. Fedde Repert. Sp. Nov. 33:55. 1934.

KEY TO THE SPECIES

1. Thallus isidiate.
    2. Medulla K+ red (salazinic acid). . . . . . *E. vexans*
    2. Medulla K- (protolichesterninic acid). *E. limaeforme*
1. Thallus lacking isidia.
    3. Thallus sorediate.
        4. Soralia diffuse over the upper surface. *E. columbiense*
        4. Soralia in discrete subterminal groups.
            5. Medulla K+ red (salazinic acid). *E. sorocheilum*
            5. Medulla K-, C+ rose (gyrophoric acid). *E. catawbiense*
    3. Thallus lacking soredia.
        6. Lower surface densely and more or less uniformly short-rhizinate.
            7. Medulla K+ red (salazinic acid group).
                8. Salazinic acid present. . . *E. nepalense*
                8. Salazinic and norstictic acids present. *E. pseudonepalense*
            7. Medulla K-.
                9. Medulla P- (no acids present). *E. ecuadoriense*
                9. Medulla P+ red.
                    10. Protocetraric acid present. *E. arsenei*
                    10. Fumarprotocetraric acid present. *E. subnepalense*
        6. Lower surface bare or with sparse, irregularly scattered long rhizines.
            11. Medulla K+ yellow turning red.
                12. Constictic acid alone present. *E. peruvianum*
                12. Salazinic acid present.
                    13. Salazinic and norstictic acids present. . . . . *E. neocirrhatum*
                    13. Salazinic acid alone present.
                        14. Thallus stiff and leathery, collected on soil and rocks in Uruguay and Argentina. *E. fistulatum*

14. Thallus not leathery; collected on trees or over humus in the mountains of tropical America (*E. cirrhatum* also in Asia).
    15. Lobes 1-2 mm wide, usually strongly involute; pantropical. . . . . *E. cirrhatum*
    15. Lobes 2-5 mm wide, flattened; collected in Mexico. . . . . *E. moreliense*

11. Medulla K-.
    16. Medulla C+ rose (gyrophoric acid).
        17. Cilia conspicuous, to 5 mm long. *E. nigrociliatum*
        17. Cilia sparse, short (1 mm long). *E. imitatum*
    16. Medulla C-.
        18. Medulla P+ orange or red.
            19. Collected in Africa; echinocarpic acid present. . . . . *E. africanum*
            19. Collected in Uruguay-Argentina; protocetraric acid present. . *E. pachydermum*
        18. Medulla P- (protolichesterinic acid).
            20. Cilia dense in tufts along the margin; collected in Chile. . . . *E. americanum*
            20. Cilia scattered, not in tufts; collected in tropical America. . . *E. lipidiferum*

LITERATURE CITED

Asahina, Y. 1968. Lichenologische Notizen. *Jour. Jap. Bot.* 43:97-101.

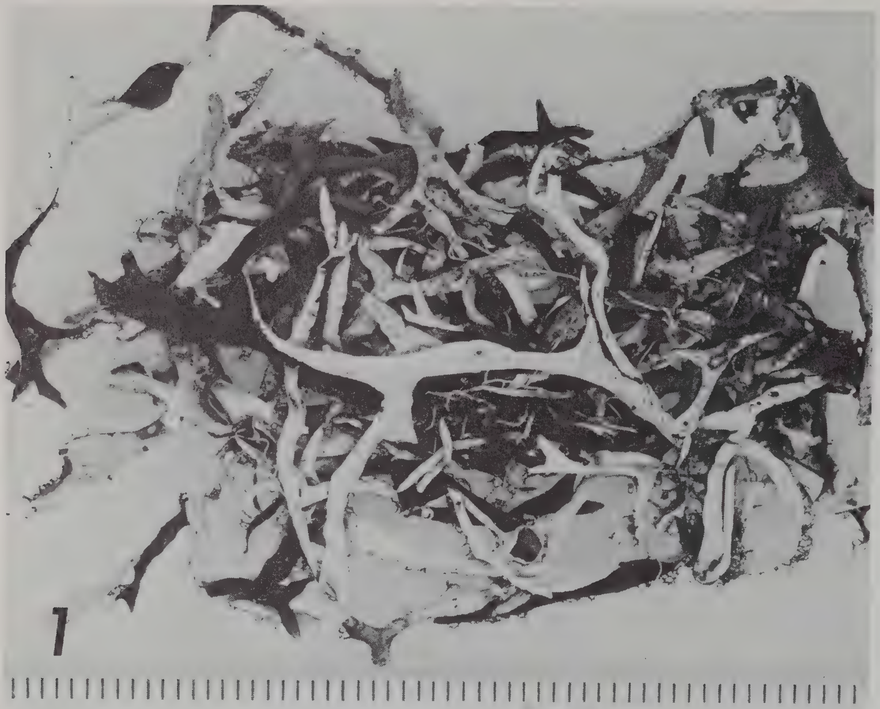
Hale, M. E., Jr. 1968. A Synopsis of the Lichen Genus *Pseudevernia*. *Bryologist*, 71:1-11.

Hale, M. E., Jr. 1973. Fine Structure of the Cortex in the Lichen Family Parmeliaceae Viewed with the Scanning-electron Microscope. *Smithsonian Contr. Bot.* 10:1-92.

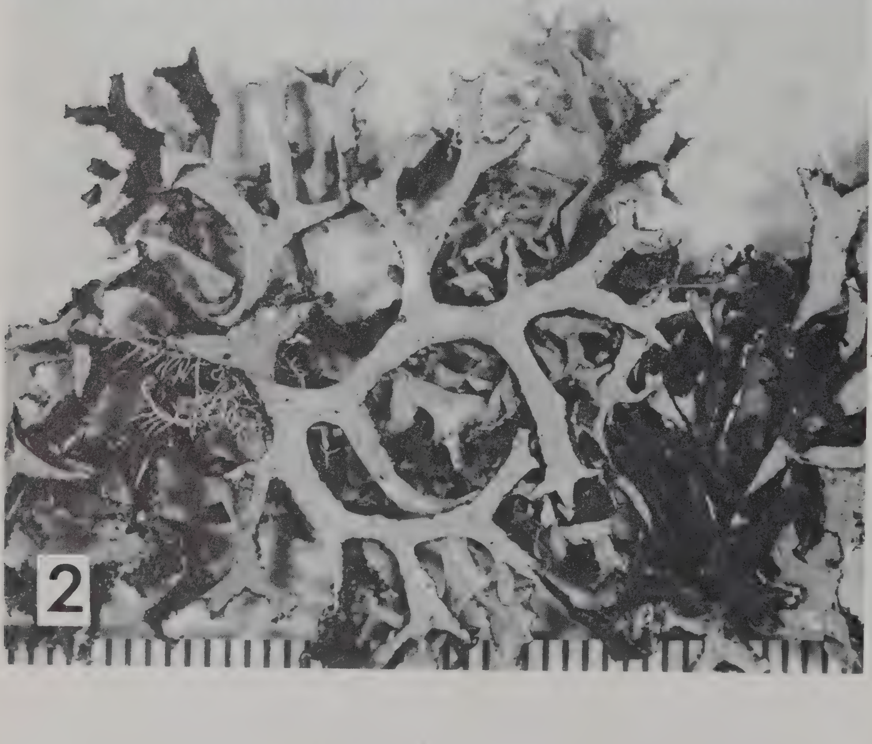
Hale, M. E., Jr. 1975. A Revision of the Lichen Genus *Hypotrachyna* (Parmeliaceae) in Tropical America. *Smithsonian Contr. Bot.* 25:1-73.

Hale, M. E., Jr., and M. Wirth. 1971. Notes on *Parmelia* subgenus *Everniiformes* with Descriptions of Six New Species. *Phytologia*, 22:36-40.

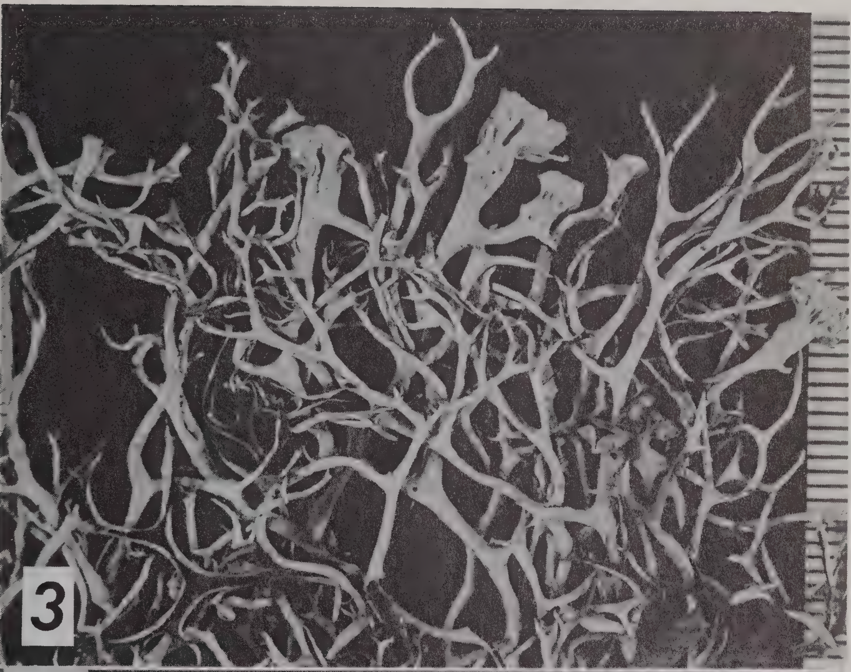
LEGENDS FOR FIGURES: Figure 1, *Everniastrum africanum* (holotype in BM); Figure 2, *E. americanum* (Mahu 2968 in US); Figure 3, *E. peruvianum* (holotype in US); Figure 4, *E. subnepalense* (holotype in US). Scale in mm.



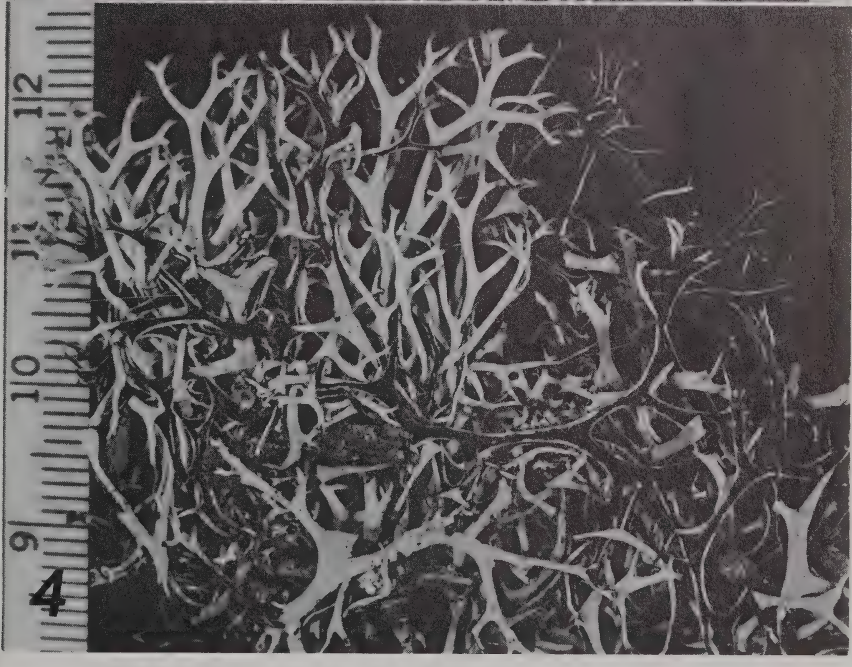
1



2



3



4

MYCOTAXON

Vol. III, No. 3, pp. 354-ff. April-June 1976

BOOK REVIEWS

by

G. L. HENNEBERT

Book Review Editor, Huttelaan 36, B-3030 Heverlee, Belgium

THE AGARICALES IN MODERN TAXONOMY, par Rolf SINGER, 3e édition complètement revue et augmentée, 1975, vi + 912 p., 84 pl. photogr. (3 coul.), ed. J. Cramer, FL-9490 Vaduz, Liechtenstein. DM 250.-

Devant cet imposant ouvrage, on ne peut s'empêcher de féliciter l'auteur pour la somme d'observations nouvelles qu'il y a réunies. Le livre n'est pas une simple réédition; l'auteur n'a pas modifié fondamentalement sa classification des Agaricales, mais l'a ajustée et enrichie.

Des Agaricales, il retire la sous-famille des Schizophylloideae, avec *Schizophyllum* de même que *Lentinellus* (Leucopaxilleae) pour les placer dans les Aphyllophorales. De même il rejette le genre *Amparoina* (Myceninae) qu'il considère comme Gastéromycète. Par contre il y inclut les Bondarzewiaceae.

Depuis la 2e édition de l'ouvrage, on trouve dans les Agaricales quelques réarrangements et des ajoutes.

Dans les Hygrophoraceae, *Aeruginospora* et *Bertrandia* sont réduits en synonymie.

Dans les Tricholomataceae, les Clitocybeae s'enrichissent d'*Arthrosporella, Lulesia, Macrocystidia, Termitomyces* (auparavant dans les Amaniteae) et *Cyphellostereum* tandis que *Pleurocybella* est reclassé dans les Collybieae, comme synonyme de *Nothopanus, Riparites* dans les Paxillaceae, *Squamanita* dans les Cystodermateae. Les Collybieae s'enrichissent de *Cheimonophyllum, Skepperiella* et *Phaeodepas* et les Resupinateae de *Stromatoscyphella* et *Aphyllotus*, tandis qu'*Asterotus* devient synonyme de *Resupinatus*.

La tribu des Marasmieae s'enrichit de trois genres, *Physocystidium, Strobilurus* et *Amyloflagellula*, mais est beaucoup amendée. Le genre *Cyphellopsis* passe aux Crepidotaceae. Des Flammulinae, les genres *Pseudohiatula* et *Cryptotrama*, avec *Xerulina* en synonymie, sont retirés pour former la tribu des Pseudohiatuleae. De même les Myceninae, sans *Amparoina*, deviennent la tribu des Myceneae. A ces tribus nouvelles s'ajoute encore la tribu des Rhodoteae, précédemment classée dans les Amanitaceae.

(continued on page 396)

MYCOTAXON

Vol. III, No. 3, pp. 355-357 April-June 1976

A NEW SPECIES OF POLYCHIDIUM (LICHENES: PELTIGERACEAE) FROM NEW GUINEA

ANTONIN VEZDA
Czechoslovakian Academy of Science, Brno, CSR.

and

WILLIAM A. WEBER
University of Colorado Museum, Boulder, Colorado 80309.

SUMMARY

Polychidium stipitatum, characterized by a well-developed excipular stipe subtending the apothecium, is described from Northeastern New Guinea.

POLYCHIDIUM STIPITATUM Vezda and W. A. Weber, *sp. nov.*

Thallus fruticulosus, crebre dichotome ramosus, corticatus, cellulae corticales flexuose connatae, 12-18 x 6-10μ, membranis crassis, ramis ambitu substrato adpressis, centro ± erectis, usque ad 5 mm altis, fuscis; ramis cylindricis, primariis ca. 0.3 mm, incrassatis, ramusculos crebros, ca. 0.1 mm crassos proferentibus. Alga ad *Scytonema* pertinens. Apothecia 0.5-0.8 mm lata, stipitata; stipites 3-5 mm longi, 0.2-0.3 mm crassi, luteofusci, simplices, rarius dichotome ramosi, ramusculis thallinis parce instructi; discus primum planus, mox tamen convexus, rufofuscus, opacus, nudus; margo integer, tenuis, luteofuscus, mox exclusus; excipulum hyalinum, ad latera hymenii 50-60μ crassum, in parte subhymeniali stipitem formans, pseudoparenchymaticum, cellulis usque ad 25μ crassis, strato corticali algisque destitutus; subhymenium pseudoparenchymaticum, hyalinum, ca. 40μ altum; hymenium ca. 80μ altum, hyalinum, IKI+ caerulescens; paraphyses simplices, rectae, septatae, 2-3μ crassae; asci numerosi, cylindrico-clavati, 8-spori; sporae late ellipsoideae, hyalinae, simplices, 8-12 x 5-7μ, membranis tenuibus. Species nova apotheciis stipitatis ab alia bene distincta.

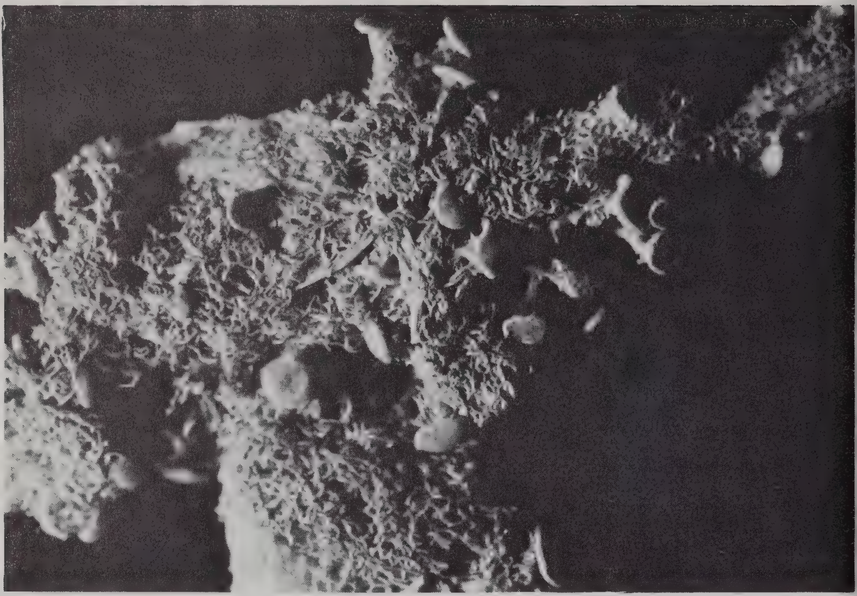


Fig. 1. Polychidium stipitatum, holotype (E. Licht photo)

Thallus fruticulose, richly dichotomously branched, forming polsters 10-20 mm diam and 5 mm high, prostrate-spreading along the edges and erect or ascending toward the center, fuscous, matte or somewhat glossy; branches cylindric, the principal axes ca. 0.3 mm thick, the lateral branchlets narrow, ca. 0.1 mm thick, intricately dichotomous; neither trichomes nor rhizines present. Thallus corticate, the cortex unistratose, its cells in surface view 12-18 x 6-10μ diam, interlocking and strongly incrassate. Phycobiont Scytonema sp., the cells 6-8u diam, the filaments running parallel to the thallus axis, appearing in cross-section as a subcortical ring, in longitudinal section showing two layers. Apothecia 0.5-0.8 mm diam, stipitate; stipe 3-5 mm long, 0.2-0.3 mm wide, yellowish-brown, simply or rarely dichotomously forked, sparingly studded with thalline branchlets; disk at first plane, soon convex, reddish-brown, matte, not pruinose; margin entire, thin, yellowish-brown, soon excluded; exciple hyaline, 50-60μ wide alongside the hymenium, decurrent to the stipe, pseudoparenchymatous, the cells up to 25μ diam, their walls 2-4μ thick; subhymenium pseudoparenchymatous, hyaline, ca. 40μ high; hymenium ca. 80μ high, hyaline, IKI+ blue; paraphyses simple, straight, septate, 2-3μ wide; asci abundant, cylindric-clavate, 8-spored; spores broad-ellipsoidal, hyaline, simple, thin-walled, 8-12 x 5-7μ.

TYPE COLLECTION. Northeastern New Guinea. Morobe District, vicinity of Samanzing, 1800-2100 m, 19 December 1938, M. S. Clemens *s.n.* (Holotype COLO L-62430; Isotype in herb. A. Vezda). On very slender twigs and small evergreen leaves of a shrub. Fig. 1.

Diagnostic for *P. stipitatum* is the elongate stipe bearing the apothecium. This feature has not been observed in any other species of the genus. The stipe is formed by the decurrent basal part of the excipulum. It shows no cortical development and lacks algal cells.

MYCOTAXON

Vol. III, No. 3, pp. 358-362 April-June 1976

CULTURAL CHARACTERISTICS OF AURISCALPIUM AND GLOIODON.[1]

Ronald H. Petersen

Botany Department, University of Tennessee, Knoxville
Tennessee 37916 USA

Summary

Cultural characteristics of *Auriscalpium vulgare* and *Gloiodon strigosum* are described and key codes furnished.

Of late, renewed interest has been shown in the taxonomy of certain genera of Aphyllophorales included generally in the families Auriscalpiaceae Maas Geesteranus (1963), Hericiaceae Donk (1964), and Clavicoronaceae Corner (1970). All three families may be characterized as typically forming gloeoplerous hyphal systems and ornamented, amyloid spores. Within the Auriscalpiaceae, Donk (1964) included *Auriscalpium* (hydnoid) *Gloiodon* (hydnoid) and *Lentinellus* (agaricoid), but cultures of only *L. cochleatus* (Fr.) Karsten have been described, and these only cursorily (Miller, 1971; Miller & Stewart, 1971). Cultures of *Hericium erinaceum* (Bull. ex Fries) S. F. Gray have been described (Davidson, et al., 1942; as *Hydnum erinaceum*), and various isolates of *Hericium* sp. were described and manipulated by Pinnix (1974), with confusing results. Dodd (1972) reported on cultural characters of *Clavicorona pyxidata* (Pers. per Fries) Doty.

The production of clavarioid fruit bodies in culture by *Lentinellus cochleatus* (Miller, 1971; Miller & Stewart, 1971) and *Gloiodon strigosum* (see below); the recent description of *Clavicorona dryophila* (Maas Geesteranus, 1973), by the author of which (Maas Geesteranus, personal communication) it is now considered a *Lentinellus*; the characteristic pyxidate branching pattern of *Clavicorona* fruit bodies; and the micromorphological similarity across all three families, have led to suggestions that the families be combined in various ways (Burdsall, personal communication; Maas Geesteranus, personal communication). It seems to me that before such action is taken, as many data as possible should be in hand, and hence the cultural characteristics of two additional species are herein described.

---

[1] Contribution no. 460 from the Botanical Laboratories University of Tennessee.

Cultures were isolated from living fruit bodies, and grown according to the regimen of Nobles (1965), and utilizing her key code. Observations were made with a Wild M20 research phase/bright field microscope.

Auriscalpium vulgare S. F. Gray

Key code: (1). 3. 15. 32. 36. 38. 45. (48). 51. 56.

Colony white to pale cream color, covering agar surface in 6 weeks, repent, not visibly forming aerial hyphae, usually with two indistinct zones at approximately 6 mm and 15 mm from inoculum block, each zone 3-4 mm wide, appearing somewhat lighter in color due to more closely packed hyphae and crystalline deposits in medium; gum guaiac test for extracellular oxidases very weak and slow or negative.

Hyphae of advancing edge: submerged hyphae 0.8-1.5 µ diam, thin-walled, hyaline, clamped, long-celled, branched at nearly 90°; surface hyphae 1.8-3.0 µ diam, straight to occasionally subhelicoid, thin-walled, invariably and conspicuously clamped, branched acutely, usually with a clamp at the branch base; dead, "empty" hyphae common, short-celled (? with *cloisons de retret*?), occasionally clamped. Gloeocystidia rare, as below.

Hyphae of mature colony: vegetative hyphae 1.5-3.2 µ diam, thin-walled, densely packed, short-celled, clamped, often gnarled or subhelicoid, frequently branched at about 45°, with clamp at branch base; contents subgranular to packed with amorphous refringent (under phase contrast) granules; walls often locally encrusted with tiny granules. Gloeocystidia common, 50-85 X 6.5-8.5 µ, clavate to elongate-clavate, often once or twice lobed, with rounded apices, thin-walled, yellow-refringent under phase contrast, arising from a clamp connection, erect at first but soon falling under its own weight and then lying on agar surface; contents foamy, coscinoidal, pale yellow. Crystalline deposits abundant in medium, as small plate-like or astral crystals randomly scattered.

Culture examined: *Auriscalpium vulgare.* New Minas, Nova Scotia, Canada, 10.1 X .73, on cones of *Pinus banksiana*, on golf course, coll. RHP, Det. RHP and K. A. Harrison, TENN no. 38206.

Observations: Gloeocystidial structures, while not unique to cultures of this taxon, are conspicuous on the colony surface, and in the absence of fruiting (see below) help to distinguish the cultures.

Fruiting was initiated on some original isolates from fruit body teeth within several weeks (on malt agar slants). When vegetative mycelium was used as inoculum, no further fruiting occurred in a subsequent year of subculturing. Conversely, when portions of fruit bodies (teeth, stipe sections, etc.) were used as inoculum, fruiting on the subculture was initiated in about 60 days, and mature fruit bodies developed in an additional 60 days, all on or very near the inoculum (within 3 mm).

In a serendipitous series of events, it was found that a random light source (cultures rotated at random at least once per day before a lateral light source) permitted fruiting, but did not permit pileus formation. When semi-mature fruiting cultures were held in a constant position relative to the same light source, pileus formation followed stipe development normally, with subsequent production of hymenium-covered teeth.

During a malfunction of the illuminated incubator in which fruiting cultures were grown, the temperature reached 54 C, killing all fruiting cultures. Consequently, only vegetative cultures are now maintained in our laboratory.

Gloiodon strigosum (Swartz ex Fries) Karsten

Key code: 1. 3. 15. 26. 33. 36. 38. 44. (48). 52.

Colony after six weeks covering agar surface, flat and very minutely granular from inoculum to approximately 4-8 mm, then abruptly farinaceous and very slightly raised; mealy appearance gradually diminishing over 2-3 cm; advancing margin (up to 1.5 cm) appearing filamentous, diffuse, mostly submerged, very delicately silky; zones very subtle, at approximately 6-8 mm, 1.5 and 2.5 cm; color of farinaceous inner zone off-white, of farinaceous outer areas pallid sand color (appreciably darker when grown in light); fruit bodies rudimentary, produced only occasionally, simple, up to 4 mm high, approximately 1.5 mm thick, cylindrical, fleshy tan to cinnamon tan in color (somewhat darker when grown in light). Odor mildly aromatic, antiseptic.

"Lead" hyphae of advancing margin up to 7 µ diam, somewhat thick-walled (wall up to 1 µ thick), hyaline, conspicuously clamped, producing narrow hyphae from or in juxtaposition to clamps; narrow submerged hyphae 1.5-2.5 µ diam, gnarled, tortuous, clamped, copiously branched; narrow surface hyphae appressed, producing differentiated structures, clamped.

Differentiated structures as follows: 1) Basidia 18-22 X 5.5-6.5 μ, clavate, clamped, hyaline, thin-walled (2)-4-sterigmate, the sterigmata very short, acute; contents homogeneous. 2) Gloeoplerous structures of two types: a) chrysocystidial elements up to 110 X 9 μ, clamped, elongate-lanceolate to narrowly cylindrical, often with one or more short protuberances produced near origin, refringent under phase contrast; contents opalescent-guttulate, strongly cyanophilous, and b) subspherical to spherical-lobose, up to 25 μ diam, often with small abrupt lobes or narrow protuberances distally, resembling aborted sterigmata; contents as in cystidia. 3) Asexual sporophores short, up to 30 μ long, 1.5-2.0 μ diam, straight, often arising from a mass of gloecystidial elements, produced singly toward the advancing margin, in greater numbers in older portion of mat to form spore "heads."

Asexual spore masses up to 0.5 mm diam, white to pallid sand color, scattered randomly over younger portions of mat, becoming so densely crowded as to appear farinaceous in older areas. Spores 8.5-10.4 X 8.1-9.3 μ, blown out hyphal tips, without constriction at point of formation, produced singly, subspherical with thick nipple-like protuberance distally, smooth, thin-walled, becoming separated from the sporophore by a septum only late in development (spores released by rupture of basal septum, occasionally with a portion of the subtending sporophore cell attached as a pedicel); contents hyaline to refringent (usually) under phase contrast, strongly cyanophilous.

Fruit bodies produced randomly over colony surface; when mature clavarioid, branched irregularly, up to 1.5 cm high, with minute papillate teeth on lower surface of upper branches, brown where sterile, grey-brown where fertile.

Culture examined: *Gloiodon strigosum*. Lowell, Oregon, 19 X .73, coll. J. L. Dodd, det. M. A. Donk, TENN no. 34822.

Observations: Light apparently plays an important function in fruit body formation in culture. Cultures kept in darkness (except for short inspection periods every few days) for six weeks produced very rare and stunted fruit bodies. Within one week after removal from darkness to normal room lighting, the size of the fruit bodies nearly doubled, branches appeared, teeth were produced on the ventral surface of the upper stipe and lower branches, and significant numbers of fruit body primordia were produced elsewhere on the colony surface. Conversely, in cultures grown in normal room light throughout their history, fruit body initials appeared within 3-4 weeks, and fruit body maturity was reached within six weeks (maturity being measured by ability to produce basidiospores).

LITERATURE CITED

Corner, E. J. H. 1970. Supplement to "A monograph of *Clavaria* and allied genera." Beih. Nova Hedwigia 33: 299 pp.

Davidson, R. W., W. A. Campbell, and D. B. Vaughn. 1942. Fungi causing decay of living oaks in the eastern United States and their cultural identification. USDA Tech. Bull. 785: 65 pp.

Dodd, J. L. 1972. The genus *Clavicorona.* Mycologia 64: 737-773.

Donk, M. A. 1964. A conspectus of the families of Aphyllophorales. Persoonia 3: 199-324.

Maas Geesteranus, R. A. 1963. Hyphal structures in hydnums. II. Koninkl. Nederl. Akad. Wetensch. C 66: 426-457.

______________________. 1973. A new *Clavicorona.* Persoonia 8: 213-226.

Miller, O. K. 1971. The relationship of cultural characters to the taxonomy of the agarics, in Petersen, R. H. Ed. Evolution in the higher Basidiomycetes. University Tennessee Press, pp. 197-215.

____________, and L. Stewart. 1971. The genus *Lentinellus.* Mycologia 63: 333-369.

Nobles, M. K. 1965. Identification of cultures of wood-inhabiting Hymenomycetes. Canad. J. Bot. 43: 1097-1139.

Pinnix, J. C. 1974. Cultural characteristics of the genus *Hericium* Pers. ex S. F. Gray. M.S. Thesis, ined, University Tennessee. 138 pp.

MYCOTAXON

Vol. III, No. 3, pp. 363-372 April-June 1976

A NEW SPECIES OF *OMPHALOTUS*

HOWARD E. BIGELOW

Department of Botany, University of Massachusetts
Amherst, Massachusetts 01002

ORSON K. MILLER, JR.

Virginia Polytechnic Institute and State University,
Blacksburg, Virginia 24061

HARRY D. THIERS

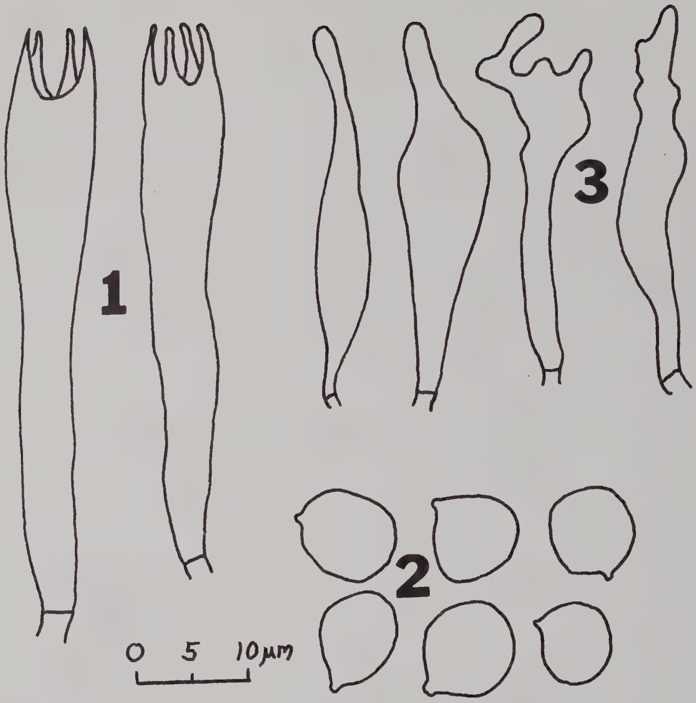
Department of Biology, San Francisco State University,
San Francisco, California 94132

For many years a large *Omphalotus* occurring on the west coast of North America has been identified variously as *Omphalotus olearius* (Fries) Singer, *Clitocybe illudens* (Schw.) Sacc. or *Monadelphus subilludens* Murr. However, a study of California collections reveals that this western agaric is quite distinct by a number of features from any of the aforementioned taxa and actually represents an undescribed species. The distribution of *Omphalotus olivascens* is not known with certainty, but it is fairly abundant in north-central California.

The colors cited in the following description are from Ridgway (1912).

Omphalotus olivascens Bigelow, Miller & Thiers, *sp. nov.*
Figs. 1-8.

Pileus 4.5-24 cm latus, convexus tum planus, tandem depressus, margine saepe irregularis, aliquando substriatus, udus, glaber vel radiato-fibrillosus, levis vel rugosus, disco interdum squamosus vel maculatus, obscuro-aurantiacus, vel luteus vel brunneo-croceus tum olivascens; contextus tenuis vel subcrassus, aquosus, lentus, subtenax, olivaceus deinde olivaceo-aurantiacus. Odor et sapor mitis. Lamellae

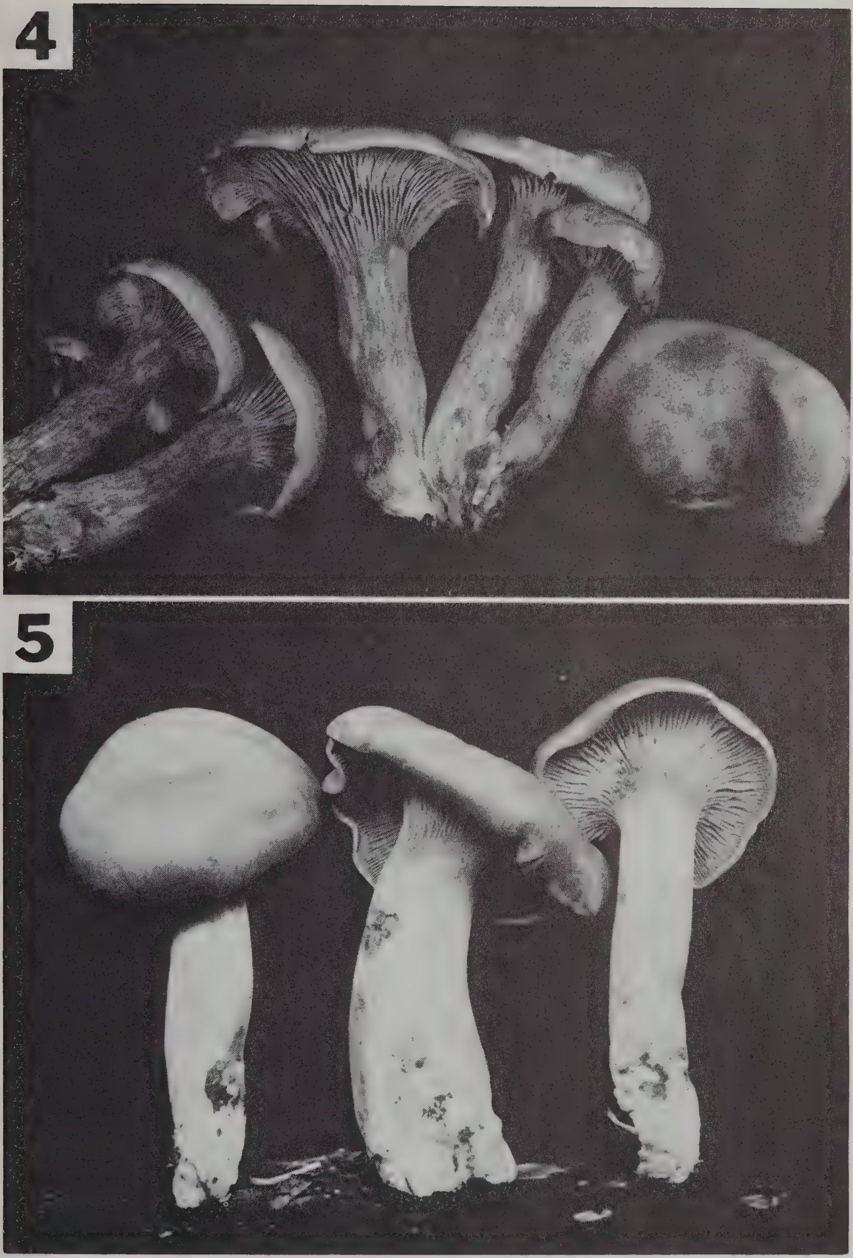


FIGS. 1-3. *Omphalotus olivascens*. 1. Basidia. 2. Basidiospores. 3. Cheilocystidia.

decurrentes, angustae vel latae, confertae vel distantes, olivaceae demum gilvae, luminescentae. Stipes 4-22 cm longus, apice 0.7-8 cm crassus, attenuatus deorsum, aliquando compressus, solidus, glaber vel subfibrillosus, olivaceus vel obscuro-sulphureus, tandem ferruginascens. Sporae (6.5-) 7-8 (-8.5) x (5-) 6-6.5 (-7.5) um, globosae ad subglobosae vel subellipticae, inamyloideae, in cumulo cremeae. Basidiocarpi caespitosi, ad lignum arborum frondosarum.

Holotypus: prope Boulder Creek, San Mateo County, California, 9 Dec. 1971, H.E.Bigelow 17015 (MASS).

Pileus 4.5-24 cm broad, convex with an inrolled and incurved margin at first, becoming broadly convex to plane, broadly depressed in larger pilei, margin irregular in age to broadly undulate, lobed or incised, arched or recurved



FIGS. 4-5. *Omphalotus olivascens*. (1/3 nat. size). Photographs by H. D. Thiers.

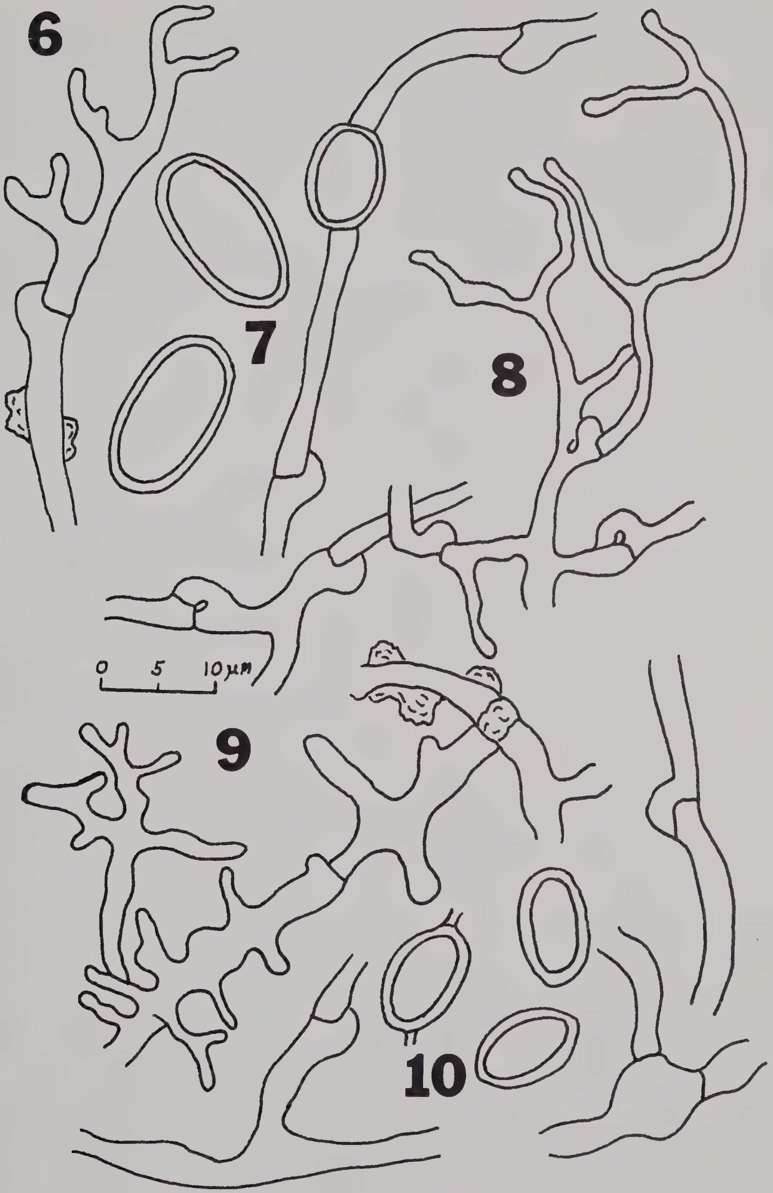
at times, sometimes short striate, surface moist, glabrous or sometimes radiate with innate fibrils, smooth or rugose, occasionally diffracted scaly on disc or with watery spots, dull orange (nearest "orange") or brownish-orange, disc tinged olive at times ("olive lake," "dull citrine") and generally olivaceous in age; context thin to rather thick (up to 2 cm thick on disc in largest caps), watery, pliant, rather tough, olivaceous when young, dull orange then olivaceous when expanded. Cap surface is dark vinaceous on contact with 3% KOH and gray with $FeSO_4$. Odor not distinctive. Taste mild.

Lamellae long decurrent and also often with decurrent ridges, narrow near pileus margin to broad near stipe (up to 15 mm), close at pileus margin to distant on stipe, intervenose and forked at times, olive mottled with honey yellow when young, becoming somewhat more yellow-orange than pileus (near a dull "capucine yellow") but olivaceous tint usually present. Luminescent.

Stipe 4-22 cm long, apex 0.7-8 cm thick, tapering downward to a point (up to 2 cm in largest specimens), sometimes fused at base, compressed at times, solid (concolorous with surface within), surface uneven, glabrous or somewhat longitudinally fibrillose, olive to olive-yellow or dull sulphur-yellow, rusty brownish stained in age.

Spores (6.5-) 7-8 (-8.5) x (5-) 6-6.5 (-7.5) µm, globose or subglobose or broadly elliptic, smooth, not amyloid, deposit cream colored ("cream color," "cream buff"). Basidia 36-50 x (5.5-) 7-8 (-10) µm, 4-spored, some basidia and basidioles with yellow refractive globules, hymenium yellowish in mass in KOH, pseudocystidia occasionally present and numerous on some lamellae, 25-46 x 5-8 µm, lageniform, ventricose-rostrate to irregular in shape (Fig. 3), thin-walled, hyaline and usually shorter than the basidia.

Pileus cutis of cylindric hyphae 1.5-8 µm in diam, thin or thickened walls, some with incrustations, in 3% KOH the incrustations, walls and oleiferous hyphae are yellow (subsurface layer with greatest concentration of pigment); context yellowish or nearly hyaline, hyphae cylindric or slightly inflated, (3-) 5-12 (-17) um diam, walls thin or thickened, rarely finely encrusted; yellow oleiferous hyphae present. Hymenophoral trama of undulate-subparallel hyphae, hyphae cylindric, 2.5-7.5 µm diam, hyaline except for yellow oleiferous hyphae (tissue paler than hymenium). Clamp connections present.



FIGS. 6-10. Cultural characters of *Omphalotus*. 6-8. *Omphalotus olivascens*. 6. Stag-horn branches of aerial hyphae. 7. Broadly elliptical chlamydospores. 8. Intricately branched submerged hyphae. 9-10. *Omphalotus olearius*. 9. Stag-horn branches of aerial hyphae. 10. Broadly elliptical chlamydospores.

Habit, habitat and distribution. Caespitose. Usually on stump or base of stump, occasionally on buried wood (recorded on wood of *Quercus agrifolia* Nee. (encina), *Arctostaphylos sp.* (manzanita), *Cercis canadensis* L. (red bud) and live *Lithocarpus densiflorus* (Hook. & Arn.) Rehd. (tan bark oak). October to February. California.

Material examined. California: Bigelow 17015 (TYPE) (MASS) (SFS), 17017 (VPI) (MASS); R.T.Orr 3038 (VPI); Smith 25 Nov 1970 (MICH); Thiers (no number) 25 Nov. 1970, San Francisco Watershed, California (MICH).

In the field, *O. olivascens* is distinguished from other species of *Omphalotus*[1] by the duller orange to yellow-orange colors which have distinctive olive overtones or stains. Numerous observations on the eastern *Omphalotus* (*Clitocybe*) *illudens* and southern *Omphalotus* (*Monadelphus*) *subilludens*, and reports in the literature on the European *O. olearius* do not mention any olive colors or stains. The color difference is maintained in herbarium material, *O. olivascens* dries much darker than any collections of the other three "species". Usually specimens of *O. olivascens* are more robust and tougher than the others, although sometimes the eastern *C. illudens* may have dimensions as large.

The microscopic characters of *O. olivascens* are similar in many respects to the other species of *Omphalotus*, although the presence of encrusted pigments in *O. olivascens* seems unique at present. Spore measurements usually are larger for *O. olivascens* when taken from deposits, but some specimens have some smaller spores (5-7 um) which lead to ranges which overlap with those of the other species. This is a confusing aspect which requires further study. The cream spore print of *O. olivascens* is not a useful distinguishing character as cream spore prints are known for both *O. illudens* and *O. olearius*, although some collections have pure white deposits. Cystidia and pseudocystidia can be found in all species if the specimens are fairly young and a sufficient number of lamellae are studied. Likewise, yellow oleiferous hyphae and yellow refractive globules in some basidia seem to be present in all taxa.

---

[1] The relationship between *O. olearius* (DC. ex Fr.) Sing., *Clitocybe illudens* (Schw.) Sacc. and *M. subilludens* Murr. is currently under study by one of us (OKM) using cultures of monosporic isolates.

CULTURAL STUDIES

Cultures of *O. olivascens* were obtained from multispore and tissue isolates from fruiting bodies collected in California by Dr. Robert T. Orr and by one of the authors (HDT). In addition, cultures of the common *Omphalotus* encountered in eastern North America are described to afford a comparison between these two taxa. This taxon has traditionally been called *Clitocybe illudens* (Schw.) Sacc. and its counterpart in Europe is now referred to as *Omphalotus olearius* (DC. ex Fr.) Sing. (Miller and Farr, 1975). This complex is under study using monokaryotic isolates from Europe and eastern North America.

The cultures were grown on malt-extract agar medium at 20°C and 25°C, according to Nobles (1948). A tannic acid medium (Davidson, et. al., 1938) was used in tests for the presence of polyphenol oxidases, as was gum guaiac solution (Nobles, 1958) on cultures of varying ages. Colors in parentheses are from Ridgway (1912) and those designated by page and block (eg. 4A5) are from Konerup and Wanscher (1967). Cultures are maintained in the Virginia Tech Culture collection (VT) and at the Center for Forest Mycology Research, Forest Products Lab., Madison, Wisconsin.

Omphalotus olivascens Figs. 6-8.

Cultures examined: VT452 (Robert T. Orr 3038, California); VT455 (Harry D. Thiers 35413, California).

Growth characters.--Growth medium, about 5.8-8.6 cm in diam in 14 days at 20°C. Advancing zone of mostly appressed hyphae, after 14 days with a silky appearance just at the margin, white to buff "light ochraceous buff," but the margin somewhat uneven with scalloped appearance. Older part of mat felty forming tufts and becoming somewhat raised near the inoculum plug, buff, "light ochraceous buff" to "ochraceous-buff," (4A5, 4A6) or "clay color" over the tufted area. In some plates a narrow, white zone, 1-2 mm, exists just around the inoculum plug. In age the older mat darkens to brown, "snuff brown" to "sayal brown". In one isolate (VT452) plate evenly brown pigmented, "snuff brown" to "sayal brown" after 20 days; other isolate, (VT455) brown color in a zone around the inoculum plug and in patches or sectors over plate with rest of mat remaining buff. Reverse side of plate bright yellow, "apricot yellow," directly beneath inoculum plug fading somewhat toward margin to "buff-yellow". After plate is covered, the yellow pigment on the reverse side also fades. Odor distinctly stale after 14 days. On tannic acid agar a strong diffusion zone develops with hyphae growing from inoculum plug onto agar. Gum guaiac turns deep blue in 4 to 10 minutes, reaction more rapid on older cultures. No luminescence observed of cultures up to three months of age.

Hyphal characters.--Advancing zone: hyphae hyaline in Melzer's solution and 3% KOH, 1-3 µm diam, frequently branched, with clamp connections. Older mat with intricately branched, submerged hyphae 0.5-2.5 µm in diam, hyaline to light yellow (Fig. 8). Aerial hyphae range up to 4 µm diam, dense yellow-brown, stag-horn branches develop after 14 days (Fig. 6) with dingy yellow-brown contents in Melzer's solution. Intercalary, broadly elliptical chlamydospores develop in 14 to 21 days (Fig. 7) attaining a size of 9-17.5 x 6-8 µm with slightly thickened walls (± 0.5 µm diam), usually becoming detached from connecting hyphal cells and floating free. Oidia not found. Stag-horn branches and other hyphae with deep yellow contents in Melzer's solution developing scattered, amyloid cell walls and amyloid incrustations on the cell walls after 30 days.

Omphalotus olearius Figs. 9-10.

Cultures examined: VT331 (O.K.Miller 6086, Washington, D.C.); VT447 (H.E.Bigelow 17145, Massachusetts).

Growth characters.--Growth moderately rapid, 8-12 cm in diam in 14 days at 25°C. Advancing zone uneven, appressed hyphae give rise to scattered raised hyphae. Older part soon appears corded and plumose, white over the entire mat except for a buff area around the inoculum plug. On close inspection the color results from yellow exudation droplets on the surface of the mat and is not a pigment in the cells. Reverse side of plate white or faintly cream color in areas around the inoculum plug beneath yellow droplets. Odor pleasant, fruity, almost like that of apple skins. On tannic acid agar a moderately strong to strong diffusion zone develops with the hyphae growing slowly from inoculum plug onto the agar. Gum guaiac tinted light grayish blue after 90 minutes or more.

Hyphal characters.--Advancing zone: hyphae hyaline in Melzer's solution and 3% KOH, 1.5-3 µm diam, frequently branched, with clamp connections. Aerial hyphae up to 3.5 µm diam with multiple-branched, deep yellow, stag-horn branches (Fig. 9) with deep yellow contents in Melzer's solution. Intercalary broadly elliptical chlamydospores develop between 14 and 21 days attaining a size of 9-10.5 x 5-5.5 µm, with slightly thickened walls (± 0.5 µm diam), and deep ochraceous in Melzer's solution (Fig. 10), usually detached and floating free. Oidia oblong, 7.6-11.5 x 2-3 µm, appearing after 10 to 30 days, thin-walled, usually hyaline to pale yellow. Small, amorphous bodies develop in 21 days as intercalary swellings. After 50 days, stag-horn branches and other hyphae with deep yellow contents in Melzer's solution develop amyloid walls and amyloid incrustations on the cell walls.

SUMMARY

The ochraceous buff to brown pigments which develop in the cultures of *O. olivascens* are never found in cultures of *O. olearius* or *O. illudens* which have only white hyphae. Pale yellow areas in the latter cultures are found, on close examination, to be yellow exudation droplets. *O. olivascens* also develops a bright yellow pigmentation on the reverse side of the culture plates of malt agar while those of *O. olearius* are white or tinted cream color. In addition, *O. olivascens* has stronger tannic acid agar reactions and the gum guaiac reaction is swifter, and has a richer blue color. The microscopic, cultural characters are similar and the distinctive chlamydospores (Figs. 7, 10) are present in *O. olivascens* and *O. olearius* but oidia have not yet been detected in *O. olivascens* cultures. After 30 days, the typical amyloid cell walls and incrustations first reported by Miller (1971) in *Omphalotus* develop in both cultures of *O. olivascens*.

In addition to these very distinctive cultural differences, the olive colors of the sporocarps of *O. olivascens*, both fresh and dried, distinguish it at once from all other taxa in the genus. The spores are generally larger and the cuticular hyphae with yellow incrustations are found only in *O. olivascens*.

ACKNOWLEDGMENTS

The authors thank Don Manning and Marie Leimer for valuable technical assistance and Dr. Robert T. Orr of the California Academy of Sciences, San Francisco, California for his assistance in obtaining cultures on which part of this study was based. We very much appreciate the critical reading of the manuscript by Dr. Alexander H. Smith of the University of Michigan, Ann Arbor, Michigan and Dr. Harold H. Burdsall, Forest Products Laboratory, Madison, Wisconsin.

LITERATURE CITED

Davidson, R.W., W.A.Campbell, and Dorothy J. Blaisdell. 1938. Differentiation of Wood-Decaying Fungi by their Reactions on Gallic or Tannic Acid Medium. Jour. Agr. Res. 57:683-695, illus.

Kornerup, A. and J.H.Wanscher. 1967. Methuen Handbook of Colour. Methuen & Co., Ltd. London. 243 p., 30 pl.

Miller, O.K. 1971. The Relationship of Cultural Characters to the Taxonomy of the Agarics, p. 197-215. *IN* "Evolution in the Higher Basidiomycetes", Ronald H. Petersen, Editor. Univ. of Tennessee Press, Knoxville, Tenn. 562 p., illus.

Miller, O.K. and D.E.Farr. 1975. An Index of the Common Fungi of North America. J. Cramer, Lehre, Germany, 206 p.

Nobles, M.K. 1948. Studies in Forest Pathology. VI. Identification of Cultures of Wood-rotting Fungi. Can. Jour. Res., C. 26:281-431.

__________. 1958. A Rapid Test for Extracellular Oxidase in Cultures of Wood-inhabiting Hymenomycetes. Can. Jour. Bot. 36:91-99.

Ridgway, R. 1912. Color Standards and Color Nomenclature, Washington, D.C. 44p., 53 pl.

MYCOTAXON

Vol. III, No. 3, pp. 373-376 April-June 1976

PSEUDOCOLUS JAVANICUS IN CONNECTICUT AND ITS DISTRIBUTION IN THE UNITED STATES

WILLIAM R. BURK

Marriott Library, University of Utah
Salt Lake City, UT 84103 U.S.A.

During the latter part of July and August 1969, 16 fruiting bodies of *Pseudocolus javanicus* (Penzig) Lloyd were found in a grassy area under *Carya* sp. in Gallagher Park, Norwalk, (Fairfield County), Connecticut. Except for 5 specimens which had 4 arms, the receptacles of the other specimens had 3 arms. The fungus was found after rainy periods and for most specimens the mycelial strands of the volva were wrapped around rotting nut shells of *Carya* sp. Some of the specimens collected are deposited in the Cryptogamic Herbarium of The New York Botanical Garden (NY). The only other occurrence of this phalloid in Connecticut is dubious and known only by a painting.

It is apparent that certain features of *P. javanicus* vary with different specimens. Sumstine's (1916) description for this fungus which he named *Colus schellenbergiae* Sumstine should be modified to include a wider range of measurements and other modifications. Sumstine described the fungus as having 3 arms, but it has 3-4 arms with deviation from this range being rare in the U.S.A. The length of the arms varies from (2.5-) 3-6 (-8) cm. The length of the basal stipe measures from 0.5-4 cm but can vary with geographical location and age of the fungus. The hyaline spores are typically ellipsoidal to cylindric and of uniform size, 1.7-2 X 4.5-5.5 μ.

The taxonomic history of this fungus is rather confusing. To date from the author's studies *P. javanicus* is considered to be the valid name. Dring (1973), Reynolds (1967) and Wright (1960) also use this epithet. Williams and Frederick (1964) and Zeller (1949) accept *Pseudocolus* as a valid genus. From both published and unpublished information the small phalloid has been found in 8 continental states and Hawaii.

Pseudocolus javanicus was first described in our country by Sumstine (1916) who named the fungus Colus schellenbergiae. This fungus was found in Pittsburgh, Pennsylvania, in July 1915 (NY[1], type specimen examined). Henry (1966) reported a reappearance of the fungus in the Pittsburgh area in 1957 (CM #19,975). Coker and Rebell (1949) indicated that the phalloid was found in Ridley Park, Pennsylvania in 1948. The fungus was found by Rogerson in 1965 on a fallen, well-rotted log along Brandywine Creek, Chester County, Pennsylvania (NY).

Seaver (1931) found the stinkhorn growing in a small area in The New York Botanical Garden in 1931. Rogerson (1969) indicated finds of the phalloid since 1960 in The New York Botanical Garden wherever wood chip mulch had been used around shrubs (NY, various specimens examined). From Rhode Island the fungus was found at Warwick Neck according to Snell and Dick (1952). Specimens sent to the author from the Kingston, Rhode Island area were found by J.M. Fenstermacher of the University of Rhode Island.

From Summit, New Jersey, Coker and Rebell (1949) reported that the fungus was found on a rotten log toward the end of rainy periods (NCU #10972). Rogerson (1969) reported that the phalloid was found growing in fine leaf mold in Caldwell, New Jersey. That find is based on only a photograph (NY). Dater (1960) found the fungus in a compost heap of leaves and twigs in September 1960 in Ramsey, New Jersey (NY).

In Millbury, Massachusetts, Snell and Dick (1956) reported the clathrate phalloid was found growing on decaying leaves in 1955. Bigelow (1959) reported finding the fungus in July and August 1958, near the University of

---

[1] Specimens that were actually examined are indicated by the herbarium abbreviation as established by Holmgren and Keuken (1974).

Massachusetts campus in Amherst (MASS #6950, 7723). The fungus was found again in the Amherst area in 1961 (MASS #9637) and 1967 (MASS #15733).

From an examination of a specimen (TENN #23098) by the author it is known that the fungus was found by L. R. Hesler in Knoxville, Tennessee in August 1958. Williams (1964) reported findings of the stinkhorn in the summer of 1963 near Atlanta, Georgia. Goos (1970) reported a collection of the fungus near Punaluu, Oahu, Hawaii, in 1969 under a stand of Eucalyptus. The specimen examined was one sent to the author. Also from the author's examination of specimen (NCU #3606) it was discovered that this phalloid was found in March 1940 in Kailua, Oahu, Hawaii, growing in a sugar cane field.

Literature Cited

Bigelow, Howard E. 1959. Interesting fungi from Massachusetts. Rhodora 61:127-136.

Coker, W. C. & G. C. Rebell. 1949. Colus schellenbergiae again. Mycologia 41:280-282.

Dater, E. 1960. "Nature Notes" In The Ramsey Journal, Ramsey, New Jersey, Journal Pub. Co. Sept. 29, p. 8, 12.

Dring, D. M. 1973. Chapter 24, Gasteromycetes, p. 451-478 In G. C. Ainsworth, Frederick K. Sparrow and Alfred S. Sussman, eds., The fungi; an advanced treatise, vol. IV-B, A taxonomic review with keys; Basidiomycetes and lower fungi. New York, Academic Press.

Goos, R. D. 1970. Phalloid fungi in Hawaii. Pacific Science 24:282-287.

Henry, L. K. 1966. David Ross Sumstine (1870-1965). Mycologia 58:175-178.

Holmgren, Patricia K. & Wil Keuken. 1974. Index Herbariorum. Part I. The Herbaria of the World. 6th ed. Utrecht, Oosthoek, Scheltema & Holkema, (for the International Bureau for Plant Taxonomy and Nomenclature). vii, 397 p.

Reynolds, Don R. 1967. A key to known Philippine Gasteromycetes. Phil. Agriculturist 51:268-278.

Rogerson, Clark T. 1969. Personal communication.

Seaver, Fred J. 1931. A rare phalloid from The New York Botanical Garden. Mycologia 23:83-84.

Snell, Walter H. & Esther A. Dick. 1952. Two phalloids from Rhode Island. Mycologia 44:150-151.

Snell, Walter H. & Esther A. Dick, 1956. An unusual phalloid from Massachusetts. Mycologia 48:327.

Sumstine, David R. 1916. A new species of Colus from Pennsylvania. Mycologia 8:183-184.

Williams, Constance Marion. 1964. Studies on genera of clathraceous fungi. M. S. Thesis. Atlanta University, Dept. of Biology, iv. 41 p. illus.

Williams, Constance Marion & Lafayette Frederick. 1964. Studies on genera of clathraceous fungi. ASB Bulletin 11(2):59.

Wright, Jorge E. 1960. Notas sobre faloideas Sud y Centroamericanas. Lilloa 30:339-359.

Zeller, S. 1949. Keys to the orders, families and genera of the Gasteromycetes. Mycologia 41:36-58.

MYCOTAXON

Vol. III, No. 3, pp. 377-380 April-June 1976

ANGIOPOMA LÉV., 1841, AN EARLIER NAME FOR DRECHSLERA ITO, 1930

B.C. SUTTON

Commonwealth Mycological Institute, Kew, England

In the course of compiling data on the generic names of pycnidial and acervular fungi and the verification of relationships of the fungi concerned by studying type collections, a number of surprising nomenclatural and taxonomic anomalies have come to light. Unusual obligate and facultative synonymies occasionally appear, and it is not an unforeseen contingency that sometimes these will involve well-known generic names (Sutton, 1972; Nag Raj & Morgan-Jones, 1972; Punithalingam, 1974). The replacement of common, frequently used generic names by obscure ones that have remained buried for more than 100 years is not in the interests of nomenclatural stability. Consequently when this situation arises it is preferable to conserve the established name, provision for which is allowed in the Code. The alternative measure by which well-known epithets may be recombined with the obscure generic name would lead to extensive name changes and is wholly unnecessary.

Angiopoma Léveillé (1841) was described as follows

'Perithecium membranaceum subcorneum, cyathiforme, ore circulari dehiscens, epiphragmate, fugaci tectum. Thecae septate pedicellatae. Sporae.... '. The genus contained a single species, A. campanulatum Lév., described as 'Gregarium; peritheciis elongatis, obconicis, atris, hirsutis. Hab. Versaliis. Ad semina Bromi sterilis. Vere.' A more discoursive account of the fungus was provided in the discussion.

Brief accounts without illustrations have appeared in Fries (1849), Saccardo (1884), Lindau (1899) and Allescher (1903) and the names have been listed in compilations by Oudemans (1919), Clements & Shear (1931) and Ainsworth & Bisby (1971). The genus has remained monotypic and no information based on type studies, has so far been presented. It has been assumed by these previous workers that Angiopoma represents a genus of Sphaeropsidales in which pycnidia are superficial, separate, elongated to obconic and hirsute, and that conidia are oblong to fusiform, brown and with several distinct septa. The Angiopoma campanulatum folder in the herbarium of the Royal

Botanic Gardens, Kew (K) contains a single specimen which can be interpreted as a type collection. It is labelled 'Herb. Berk. 1879' and bears an additional label with the following hand-written annotation '*Angiopoma campanulatum*, Lév. Ann. Sc. nat.' Dr. R.W.G. Dennis and Dr. D.A. Reid have kindly verified that the handwriting belongs to J.H. Léveillé and since the latter is the author of the genus and species it seems reasonable to deduce that this specimen is certainly authentic for the name and most probably an isotype. The lack of additional data concerning the specimen would seem to preclude a definitive decision over typification of the name, but since in all respects the fungus agrees with the description of Léveillé it is not injudicious to designate this collection as the lectotype for the name. A description of the fungus based on this specimen follows. It verifies the illustrations of conidia and conidiophores made by Berkeley on the type sheet.

Stromata erect, cylindrical, dark-brown to black, 1200μ high x 300μ wide, consisting of thick-walled, large-celled pale brown pseudoparenchyma which at the periphery is composed of a layer 1-2 cells thick of dark brown sclerotioid cells. There was no evidence of enlargement at the base and neither ascogenous tissue nor ascospores were found. Conidiophores straight or flexuous, swollen at the base, rarely geniculate, dark brown, paler towards the apices, verruculose, 225 x 10μ septate, formed from the sclerotioid cells of the stromata. Conidiogenous cells polytretic, integrated, terminal, sympodial, cicatricized with 1-3 dark brown scars. Conidia solitary, cylindrical, straight, golden brown, obtuse at the apex, base cicatricized, smooth, 5-6 distoseptate, 45-75 x 14-17μ.

These observations clearly indicate that *A. campanulatum* is not pycnidial at all but a hyphomycete. The combination of generic characteristics places it in *Drechslera* Ito where it can be readily identified as *D. verticillata* (O'Gara) Shoemaker, conidial *Pyrenophora semeniperda* (Brittlebank & Adam) Shoemaker. The stromata and conidiophores match perfectly, although the number of distosepta and conidial length are somewhat lower than the dimensions given by Shoemaker (1966) and Ellis (1971). However, the fact that *A. companulatum* was described from seeds of *Bromus sterilis* and forms conidiophores from cylindrical stromata leaves little doubt that *A. campanulatum* and *D. verticillata* are conspecific, for the latter is not only the solitary *Drechslera* species to produce stromata on natural substrata, but is typically recorded as a pleomorphic parasite of cereal seeds and has been reported by Shoemaker (1966) from seeds of *Bromus sterilis* and other *Bromus* species.

Angiopoma therefore antedates *Drechslera* by 89 years and could be taken up in preference to the latter for it has date priority. However, because *Angiopoma* has remained dormant since its inception (apart from routine listings in compilations and repetitions of the original diagnosis in subsequent general mycological treatises), and *Drechslera* has for several years now been used and accepted as the name for an important group of about 50 pathogens of Gramineae, many of which have been the subject of several correlative studies with *Pyrenophora* Fr. and related genera, it seems preferable to propose the conservation of *Drechslera* against *Angiopoma.* I am making a formal proposal to this effect in *Taxon.* In anticipation that conservation will be approved, the following new combination is proposed for the conidial state of *P. semeniperda*: - *Drechslera campanulata* (Lév.) comb. nov. (syn. *Angiopoma campanulatum* Lév., *Ann. Sci. nat.*, 2 ser., 16 : 235, 1841).

It is a pleasure to acknowledge the useful discussion I have had with Dr. M.B. Ellis, and the assistance in determining the Léveillé handwriting by Dr. R.W.G. Dennis and Dr. D.A. Reid. Dr. R.A. Shoemaker kindly made useful comments on the manuscript prior to submission. The permission of Dr. D.A. Reid (K) to examine collections in his keeping is also acknowledged.

References

Ainsworth, G.C. & Bisby, G.R. (1971). *Dictionary of the fungi.* Ed. 6. Commonwealth Mycological Institute, Kew.

Allescher, A. (1903). Rabenhorst's *Kryptogamen Flora.* 1. Die Pilze. VII. Fungi imperfecti: Gefarbt-sporige Sphaerioideen sowie Nectrioideen, Leptostromaceen, Excipulaceen und der Ordnung der Melanconieen. E. Kummer, Leipzig.

Clements, F.E. & Shear, C.L. (1931). *The genera of fungi.* Hafner, New York.

Ellis, M.B. (1971). *Dematiaceous hyphomycetes.* Commonwealth Mycological Institute, Kew.

Fries, E.M. (1849). *Summa Vegetabilium Scandinaviae.* Uppsala.

Léveillé, J.H. (1841). Description de quelques espèces nouvelles de Champignons. *Ann. Sci. nat.*, 2 ser. 16 : 235-242.

Lindau, G. (1899). Engler & Prantl, *Die naturlichen Pflanzenfamilien* 1 (1**) 1, Fungi imperfecti, Fungi fossiles: 347-523.

Nag Raj, T.N. & Morgan-Jones, G. (1972). Nomina conservanda proposita (332). *Taxon* 21: 531-546.

Oudemans, C.A.J.A. (1919). *Enumeratio Systematica Fungorum*

1 : 1-1230.

Punithalingam, E. (1974). Studies on Sphaeropsidales in culture. II. Mycol. Pap. 136: 1-46.

Saccardo, P.A. (1884). Sylloge fungorum 3. Pavia.

Shoemaker, R.A. (1966). A pleomorphic parasite of cereal seeds, Pyrenophora semeniperda. Can. J. Bot. 44 : 1451-1456.

Sutton, B.C. (1972). Nomenclature of Ceuthospora, Pyrenophora and Blennoria (Fungi). Taxon 21 : 319-326.

MYCOTAXON

Vol. III, No. 3, pp. 381-386 April-June 1976

LEPIOTA SENSU LATO IN CALIFORNIA. II. TYPE STUDIES OF *LEPIOTA CUPRESSEA* AND *LEPIOTA MARGINATA*

WALTER J. SUNDBERG

Department of Botany, Southern Illinois University,
Carbondale, Illinois 62901

SUMMARY

Anatomical features of the type collections of *Lepiota cupressea* Burlingham and *Lepiota marginata* Burlingham are described and illustrated.

A serious problem presently confronting monographers of *Lepiota* is the lack of accurate information on many anatomical features which were overlooked by earlier workers but are now considered essential for developing clear systematic concepts (Smith, 1966). This paucity of data has been partially overcome with the recent publication of H. V. Smith's (1966) type studies. In an effort to further alleviate this situation, detailed anatomical descriptions of *Lepiota cupressea* Burlingham and *L. marginata* Burlingham, two California taxa presently known only from their original descriptions (Burlingham, 1945), are presented below.

The two type collections, which were recently rediscovered by Dr. Clark Rogerson who kindly informed me of their availability, are housed at the New York Botanical Garden (NY). The included size ranges were derived from measurement of a minimum of 15 cells or segments. Illustrations were made with the aid of a Leitz drawing tube, and colors in quotation marks are from Ridgway (1912).

LEPIOTA CUPRESSEA Burlingham, Mycologia 37: 53. 1945.

Basidiospores (Fig. 3) almost white (dark "waxy yellow", near light "cream color"), and rapidly dextrinoid (dark reddish brown) in mass; 8-10 x 4.6-6 µm (average 9 x 5.6 µm); ovoid to short ellipsoid, apiculate, occasionally with a subpapillate (superficially cap-like) apex, inequilateral in side view; walls smooth, thickened as seen in KOH-phloxine mounts, often somewhat thicker toward the base than at the apex, apical pore lacking; frequently uniguttulate; hyaline in KOH and dextrinoid (dark reddish brown) when viewed singly in Melzer's reagent.

Basidia 27-33.4 x 7.4-9.5 µm (average 30.5 x 8.4 µm); 4-spored, clavate; walls smooth; contents scantily and finely granulose (not distinctive); hyaline in KOH and pale yellow in Melzer's reagent.

Cheilocystidia (Fig. 1) abundant; 22-58.7 x 10-15.4 µm (average 37.3 x 12.7 µm); ventricose to clavate to sphaeropedunculate, often broadly rostrate at the apex when ventricose, many with narrow elongate bases; walls thin, smooth; hyaline to dull pale brown in KOH and pale yellow in Melzer's reagent.

Pleurocystidia lacking.

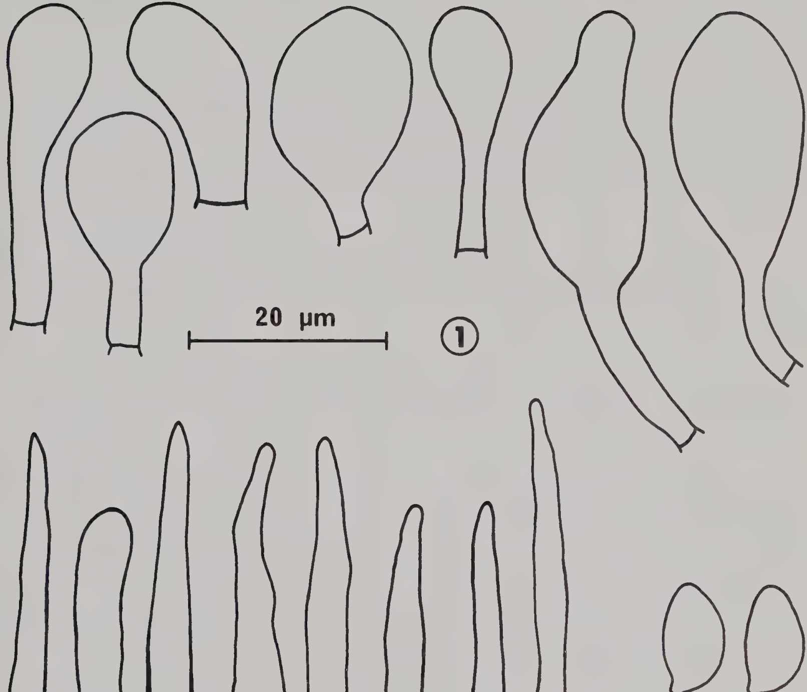
Lamellar trama interwoven, hyaline in KOH and pale yellow in Melzer's reagent; subhymenium subcellular, concolorous.

Pileal trama interwoven; hyaline in KOH and pale yellow in Melzer's reagent.

Cuticle a trichodermium of upright pilocystidia arising from a tightly interwoven layer. Pilocystidia (Fig. 2) 52-279 x 10-18.8 µm (average 155 x 14.5 µm); very elongate-clavate to elongate-ventricose, apices rounded, usually tapered; walls smooth, occasionally somewhat flexuous, thin above and gradually thickened toward the base; dull pale brown in KOH (pigment in walls) and pale yellowish brown with a granulose but not distinctly colored content in Melzer's reagent. Subcuticular cells tightly interwoven; 4.3-11.5 (-14.4) µm broad, (average 7.6 µm), generally narrower than the pilocystidia; often with an irregularly encrusted surface.

Clamp connections lacking.

A pale yellowish brown pigment diffuses out of the


20 µm
①
50 µm
②
10 µm
③

Figs. 1-3. *Lepiota cupressea*. 1. Cheilocystidia. 2. Pilocystidia. 3. Basidiospores. (Detail as seen in phloxine-stained KOH mount).

tissue in water after alcohol treatment during sectioning preparation.

In the type collection, the lamellae, which were originally described as "white fimbriate, staining first yellow then salmon and finally sepia", are entirely dull brownish olive ("light brownish olive" to near "citrine drab").

Material examined: G. S. Burlingham 9 March 15, 1937, Point Lobos, Monterey Co., California (HOLOTYPE-N.Y.).

LEPIOTA MARGINATA Burlingham, Mycologia 37: 55. 1945.

Basidiospores (Fig. 5) almost white (pale "waxy yellow") and rapidly dextrinoid (dark reddish brown) in mass; 6.2-9 x 4.3-5.9 µm (average 7.7 x 5 µm), ovoid to short ellipsoid, apiculate; walls smooth, appearing somewhat thickened as seen in KOH-phloxine mounts, often with walls somewhat thicker toward the base than at the apex, apical pore lacking; hyaline in KOH and dextrinoid (dark reddish brown) when viewed singly in Melzer's reagent.

Basidia 21.6-31 x 5.6-8 µm (average 26 x 7 µm); 4-spored, clavate; contents not distinctive; hyaline in KOH and pale yellow in Melzer's reagent.

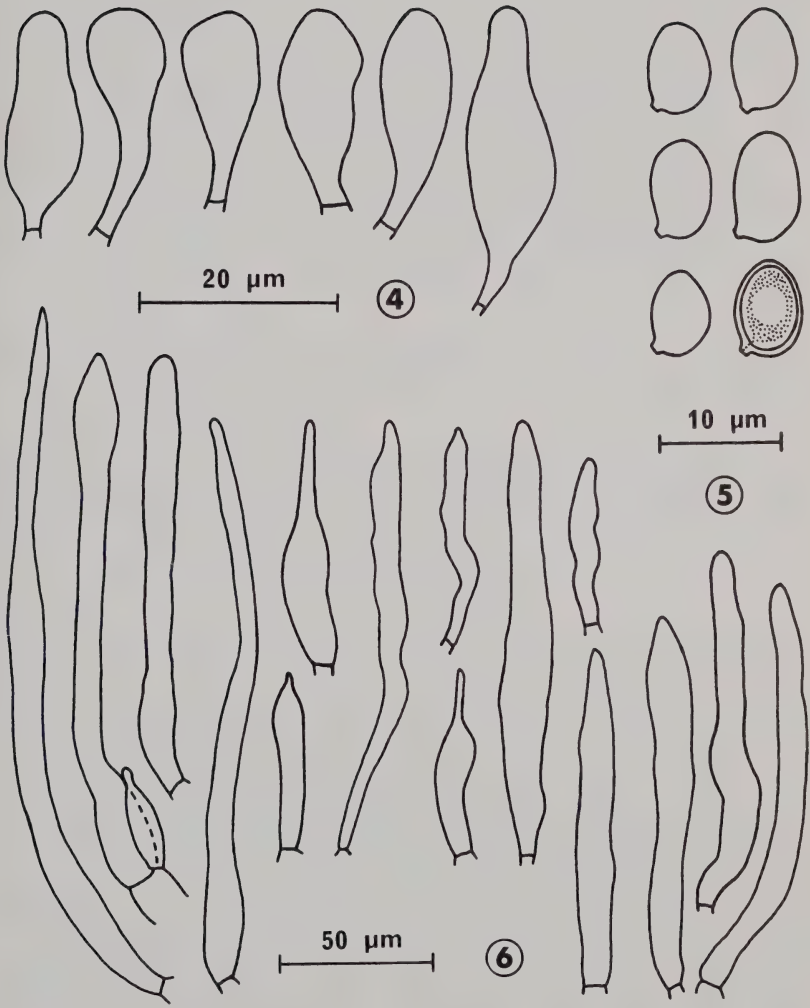
Cheilocystidia (Fig. 4) 15.4-37.7 x 6-12.4 µm (average 28.4 x 9 µm); narrowly clavate to clavate to ventricose, rarely almost subsaccate, often broadly to narrowly rostrate, bases sometimes narrow and elongate; walls thin, smooth; hyaline in KOH and pale yellow in Melzer's reagent.

Pleurocystidia lacking.

Lamellar trama interwoven; hyaline in KOH and pale yellow to near hyaline in Melzer's reagent; subhymenium subcellular, concolorous.

Pileal trama tightly interwoven immediately beneath the cuticle, elsewhere loosely interwoven, hyaline in KOH and pale yellow in Melzer's reagent.

Cuticle a trichodermium of upright pilocystidia and infrequent upright hyphae composed of short subterminal


20 µm
④
10 µm
⑤
50 µm
⑥

Figs. 4-6. *Lepiota marginata*. 4. Cheilocystidia. 5. Basidiospores. (Detail as seen in phloxine-stained KOH mount). 6. Pilocystidia.

segments and elongate, pilocystidium-like, terminal elements. Pilocystidia and terminal elements (Fig. 6) 45-223 x 7-14.5 µm (average 113 x 10 µm); elongate-cylindric to very elongate-ventricose (abruptly to gradually tapered toward the apex), apices rounded, occasionally rostrate; walls smooth, sometimes flexuous, more or less equal in some, thin and hyaline above to distinctly thickened and darker below in others; dark brown to pale yellow in mass and pale brown to almost hyaline when viewed singly in KOH. Subcuticular hyphae 4.3-10 µm broad (average 6.5 µm), often externally encrusted (sometimes heavily so), more or less concolorous with terminal elements.

Clamp connections lacking.

A yellowish brown water soluble pigment diffuses out of the tissue after alcohol treatment during sectioning preparation.

Material examined: G. S. Burlingham 13 April 10, 1937, Point Lobos, Monterey Co., California (HOLOTYPE-N.Y.).

LITERATURE CITED

BURLINGHAM, G. S. 1945. Noteworthy species of *Lepiota* and *Lactaria*. Mycologia 37: 53-64.

RIDGWAY, R. 1912. Color standards and color nomenclature. Washington, D. C. 43 p., 53 plates.

SMITH, H. V. 1966. Contributions toward a monograph on the genus *Lepiota*, I. Type studies in the genus *Lepiota*. Mycopath. Mycol. Appl. 29: 97-117.

MYCOTAXON

Vol. III, No. 3, pp. 387-390 April-June 1976

A NEW SPECIES OF EOTERFEZIA FROM MEXICO AND VENEZUELA[1]

R.S. JENG and R.F. CAIN

Department of Botany, University of Toronto
Toronto, Canada

SUMMARY

Eoterfezia perlucida sp. nov., parasitic on the perithecia of species of *Arnium* and *Podospora*, is described and illustrated from burro and cow dung. This species is characterized by hyaline ascocarps; globose, evanescent asci; and hyaline, smooth, ellipsoidal ascospores. It differs from *E. parasitica* in the larger ascospores.

INTRODUCTION

In a study of coprophilous fungi, clusters of discomycete-like ascocarps were observed on collections of burro and cow dung from Mexico and Venezuela. Closer examination revealed that these ascocarps were parasitic on the perithecia of species of *Podospora* Cesati and *Arnium* Nits. in Fuckel. Each ascocarp was found to contain numerous globose asci covered by a membrane-like peridium, characteristics typical of the cleistothecial Ascomycota. A comparison with *Eoterfezia parasitica* Ait. indicated that the two organisms are con-generic. *E. parasitica* is characterized by being parasitic on perithecia of species of *Sordaria* Ces. et DeNot., possessing non-ostiolate ascocarps with a thin membranous peridium, and one-celled, hyaline, smooth ascospores measuring 3.0-4.5 x 1.5-2.5μ. However, *E. parasitica* differs in the size of the ascospores, structure of the peridium and the presence of capillitium-like filaments. On account of these differences, our fungus is being described as a new species.

---

[1] Supported by grants from the National Research Council of Canada.

Eoterfezia is the type genus of the Eoterfeziaceae as established by Atkinson (1902). Besides this taxon, a number of other cleistocarpous genera were included by Malloch and Cain (1971). These included *Cleistothelebolus* Malloch et Cain, *Lasiobolidium* Malloch et Cain, *Microeurotium* Ghatak, *Orbicula* Cooke and *Xeromyces* Fraser.

TAXONOMY

Eoterfezia perlucida Jeng and Cain sp. nov. Figs. 1-4.

Ascocarpi 90-500μ diametro crassi, aggregati, primum globosi vel subglobosi, per maturitatem in discoidei vel convexi facti, erminei vel lutei, leves, glabri; peridium membrnanceum, perlucidum, e stratis duobus compositum. Asci 10-12μ diametro magni, octospori, globosi, evanescentes. Ascosporae 4.9-6.5 x 3.5-4.5μ magnae, ellipsoideae, hyalinae, leves, sine foramine germinali. Conidia incognita.

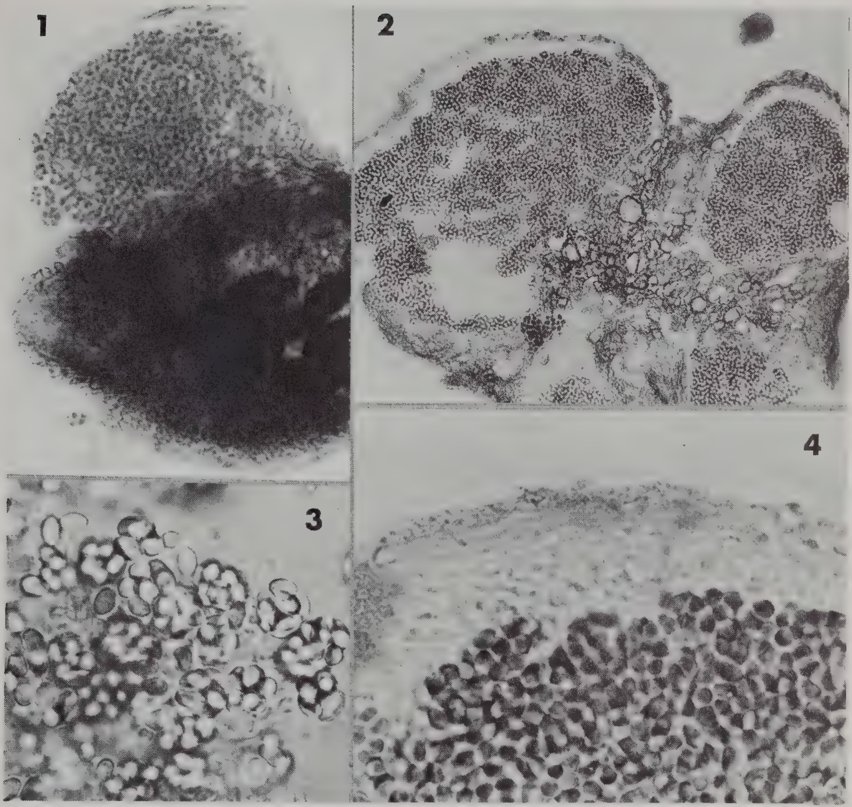
HOLOTYPUS: in equorum fimo lectus est, in calle a Manacal ad Los Pocitos vocato, in loco ab Irapa septentrionali-occidentali remoto, in Sucre pago reipublicae Venezuelensis, 13 Quint. 1972, *Dumont*, *Cain*, *Samuels*, *Morillo* et *Farfan* VE-4890s. In Torontoensis Universitatis Cryptogamarum herbario.

ETYMOLOGY: Latin, *perlucidus* = transparent, referring to the transparent character of the peridium.

Ascocarps 90-500μ in diameter, arising mostly in clusters from the host peridium, initially globose or subglobose, becoming discoid to convex at maturity, cream to yellowish, smooth, bare. *Peridium* 14-24μ thick, membranaceous, transparent, with cellular structure obscure in surface view, two-layered in cross section; outer peridial layer 4.5-9.0μ thick, hyaline, appearing as a fine granular layer in Gurr's mounting medium; inner peridial layer 9.0-15.0μ thick, composed of angular, hyaline cells measuring about 3.0 x 5.0μ. *Asci* 10.0-12.0μ in diameter, 8-spored, globose, thin-walled, evanescent. *Ascospores* 4.9-6.5 x 3.5-4.5μ, ellipsoidal, hyaline, smooth, without germ pores. Conidial stage unknown.

HABITAT: Parasitic on the perithecia of species of *Podospora* and *Arnium* from burro and cow dung.

SPECIMEN EXAMINED: VENEZUELA: Edo Sucre: NW. of Irapa, trail between Manacal and Los Pocitos, burro dung, 13 July 1972, *Dumont*, *Cain*, *Samuels*, *Morillo* and *Farfan* VE-4890s



Figs. 1-4. Eoterfezia perlucida (Type). 1. An ascocarp parasitic on the perithecium of Podospora communis. x265. 2. Cross section of several ascocarps showing the masses of ascospores in the ascocarp cavities. x140. 3. Mature asci and ascospores. x665. 4. Cross section of an ascocarp showing the outer non-cellular peridial layer, the inner pseudoparenchymatous layer and the masses of ascospores. x590.

(TRTC); Rte. 10, ca. 20 km. S. of Carupano, cow dung, 16 July 1972, Dumont, Cain, Samuels and Morillo VE-5156j (TRTC). MEXICO: San Luis Potosi: Cuidad del Maiz, burro dung, 19 August 1960, Cain, TRTC 36736 (TRTC).

E. perlucida is parasitic on the perithecia of Podospora communis (Speg.) Niessl and Arnium absimile (Cain) Krug et Cain. The new species differs from E. parasitica in possessing (1) a peridium composed of two layers - the outer being hyaline, granular and non-cellular and the inner pseudoparenchymatous (2) numerous, globose asci with which were associated some hyaline, septate filaments and (3) larger ascospores. Unfortunately the origin of the filaments amongst the asci could not be traced but they are believed to be ascogenous hyphae rather that capillitium-like threads as reported for E. parasitica.

ACKNOWLEDGEMENTS

We wish to express our appreciation to Dr. J.C. Krug for assistance in correcting the Latin diagnosis and revising the manuscript.

LITERATURE CITED

Atkinson, G.F. 1902. Three new genera of the higher fungi. Bot. Gaz. 34: 36-43.

Malloch, D. and R.F. Cain. 1971. Four new genera of cleistothecial Ascomycetes with hyaline ascospores. Can. J. Bot. 49: 847-854.

MYCOTAXON

Vol. III, No. 3, pp. 391-395 April-June 1976

A NEW SPECIES OF ASCODESMIS FROM VENEZUELA[1]

R.S. JENG and R.F. CAIN

Department of Botany, University of Toronto
Toronto, Canada

SUMMARY

Ascodesmis caninus sp. nov. is described and illustrated from dog dung collected in Venezuela. A. caninus is characterized by minute, hemisphaerical apothecia with a poorly developed or reduced excipulum; broadly clavate asci; and globose to subglobose ascospores with walls possessing numerous, tiny pits. This taxon differs from previously known species in possessing pitted ascospores.

INTRODUCTION

While studying the coprophilous fungi of Venezuela, one apparently undescribed, small, hemisphaerical discomycete was observed. This organism, which was isolated from some dog dung maintained in a moist chamber containing malt-yeast agar, appears to represent a new species of Ascodesmis van Tieghem.

This genus was established by van Tieghem (1876) to accommodate A. nigricans van Tieghem, which is a small operculate discomycete. It is characterized by possessing ascocarps with a poorly developed or reduced excipulum as well as asci and paraphyses which develop from a clump of basal cells. Currently there are five recognized species, four of which were critically studied by Obrist (1961). He, as well as most modern mycologists, considers the genus primitive from an evolutionary viewpoint. The taxon was allocated to the Humariaceae by Obrist, but Korf (1972) considered it to be better placed in the Pyronemataceae.

---

[1] Supported by grants from the National Research Council of Canada.

TAXONOMY

Ascodesmis caninus Jeng & Cain sp. nov. Figs. 1-14

Apothecia minuta, hemisphaerica, 300-400μm diametro crassa, dispersa aut aggregata, hyalina, sine exciplo, ex ascis et paraphysibus a cellulis basalis factis composita. Asci 66-98 x 30-45μm magni, operculati, octospori, unitunicati, in apice late clavati, basin versus in stipitem brevum abrupte contracti. Paraphyses numerosae, septatae, hyalinae, in apice 6.0-7.0μm diametro crassae. Ascosporae unicellulares, 15-21 x 12-16μm magnae, globosae vel subglobosae, aggregatae, primum hyalinae, maturitate confirmata brunneae vel atribrunneae, parietibus crassis, foveolas numerosas minutas exhibentes, primum vagina hyalina gelatinosa circumdatae. Conidia incognita.

HOLOTYPUS: in caninorum fimo lectus est, secus flumen Aguas Calientes vocatum, ab oppido Maraval ad septentriones remoto, in loco ab Irapa septentrionali-occidentali vocato, in Sucre pago reipublicae Venezuelensis, 8 Quint. 1972, Dumont, Cain, Samuels, Morillo et Villegas VE-4338b. In Torontoensis Universitatis Cryptogamarum herbario.

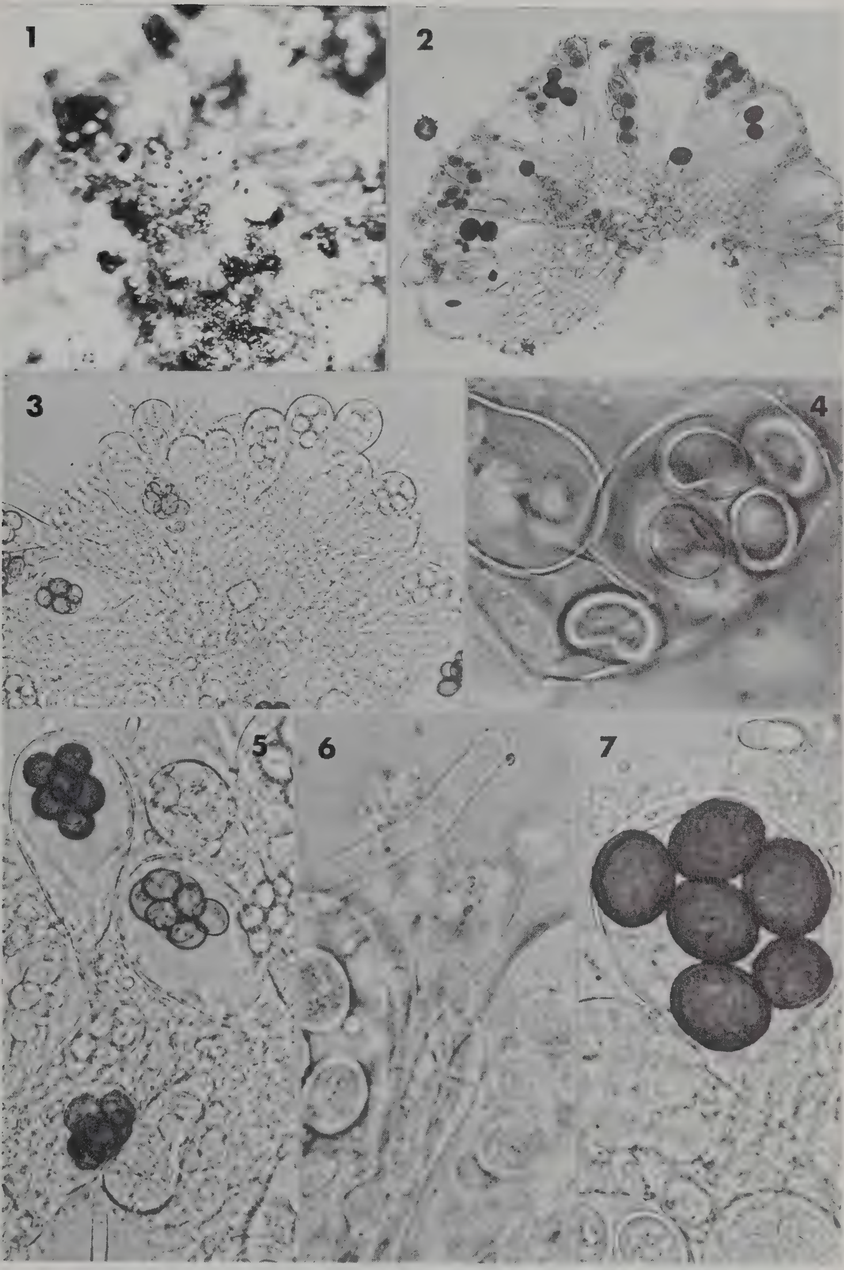
ETYMOLOGY: Latin, caninus = of dogs, referring to the type of substrate.

Apothecia minute, hemisphaerical, 300-400μm in diameter, scattered or aggregated, hyaline, without excipulum, consisting of asci and paraphyses originating from a clump of basal cells. Asci 66-98 x 30-45μm, operculate, nonamyloid, 8-spored, occasionally less, unitunicate, broadly clavate, rounded above, abruptly contracted below into a short stripe. Paraphyses numerous, stout, septate, hyaline, unbranched, 6.0-7.0 μm in diameter at the apex. Ascospores one-celled, 15-21 x 12-16μm, globose to subglobose, crowded together, initially hyaline, becoming brown to dark brown at maturity, thick-walled, with walls ornamented with numerous tiny pits, surrounded by a gelatinous sheath when young. Conidia unknown.

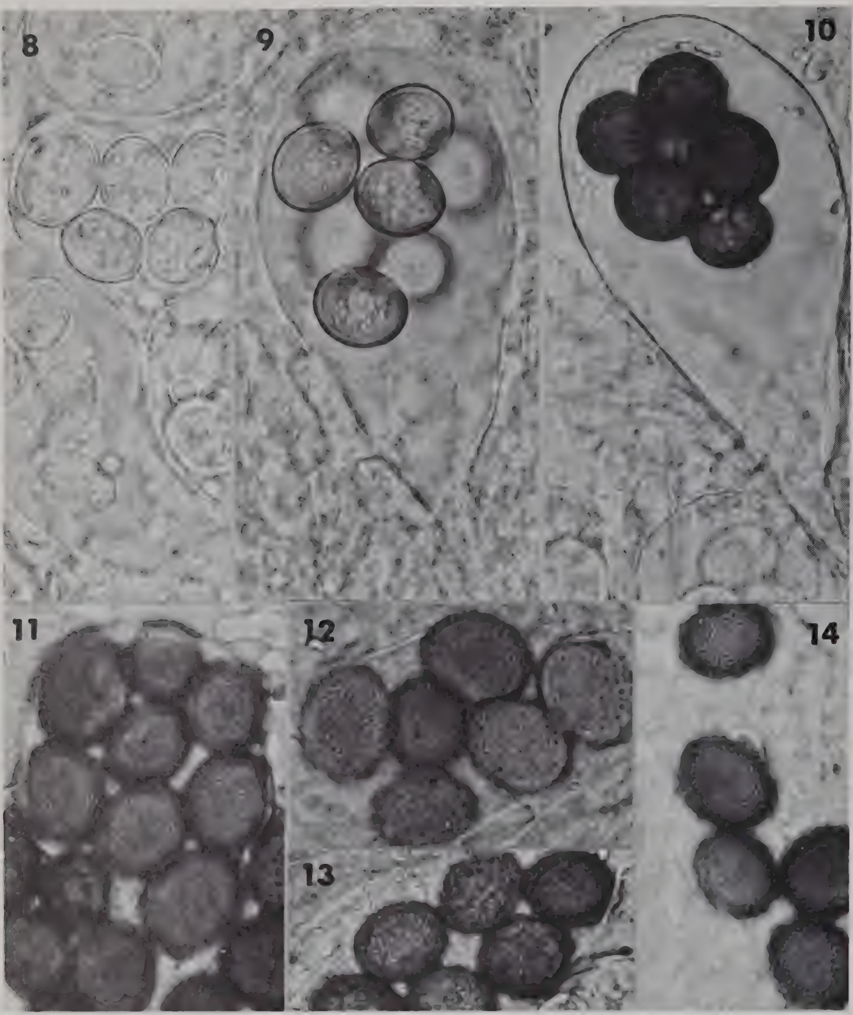
HABITAT: On dog dung.

SPECIMEN EXAMINED: VENEZUELA: Edo. Sucre: NW. of Irapa, half hour walk N. of Maraval, along Rio Aguas Calientes, dog dung, 8 July 1972, Dumont, Cain, Samuels, Morillo and Villegas VE-4338b (TRTC).

Like the other known species of Ascodesmis, our new taxon possesses minute, hemisphaerical apothecia with a poorly developed excipulum. However, A. caninus can be



Figs. 1-7. *Ascodesmis caninus*. 1. Habit view of apothecia. x24. 2. Longitudinal section of an apothecium. x140. 3. Portion of a squashed apothecium.



x140. 4. Upper part of an ascus showing young ascospores with gelatinous sheath. x640. 5. Portion of a squashed apothecium. x300. 6. Apical portion of the paraphyses. x640. 7. Mature ascospores. x640.

Figs. 8-14. Ascodesmis caninus. 8. Ascospores at the hyaline stage. x640. 9. Pigmented young ascospores. x640. 10. Mature ascospores. x640. 11-14. Mature ascospores showing the pitted walls. x640.

recognized easily by its pitted, thick-walled ascospores which are often variable in number, size and shape. Six to eight-spored asci were observed to be rather common. In contrast to some species of the genus which commonly possess ascospores with a perisporium, those of A. caninus initially are covered by a distinct gelatinous sheath. This gradually becomes invisible as the ascospores reach maturity.

This genus has sometimes been assigned to the Gymnoascaceae because of the simplicity in the structure of the ascocarp. In fact Eleutherascus von Arx, which was considered with the other genera of the Gymnoascaceae, was regarded by von Arx (1971) as a primitive discomycete lacking ascocarps. This genus resembles Ascodesmis in possessing simple ascocarps and ascospores which are ornamented with either spines or short ridges or both. The similarity between these two genera has also been pointed out by Huang (1975) from cultural and morphological observations. Like von Arx (1971), he implies that Eleutherascus may be related to Ascodesmis. The presence in this genus of both operculate asci and more complicated ascocarp initials would exclude Ascodesmis from the Gymnoascaceae. Actually, this family, like Eleutherascus, may be related to the primitive discomycetes.

ACKNOWLEDGEMENTS

We wish to express our appreciation to Dr. J.C. Krug for assistance in correcting the Latin diagnosis and revising the manuscript.

LITERATURE CITED

Arx, J.A. von. 1971. Arachniotus and related genera of the Gymnoascaceae. Persoonia 6: 371-380.

Huang, L.H. 1975. A new species of Eleutherascus from Peruvian soil. Mycologia 67: 293-302.

Korf, R.P. 1972. Synoptic key to the genera of the Pezizales. Mycologia 64: 937-994.

Obrist, W. 1961. The genus Ascodesmis. Can. J. Bot. 39: 943-953.

van Tieghem, Ph. 1876. Sur de développement du fruit des Ascodesmis genre nouveau de l'ordre des Ascomycètes. Bull. Soc. Botan. France. 23: 271-279.

BOOK REVIEWS *(continued from page 354)*

Des Amanitaceae (imprimé erronément V. Pluteaceae, p. 162) on ne retient que *Amanita* et *Limacella,* tandis que les Pluteaceae (imprimé erronément Volvariaceae, p. 162) en sont écartées.

Aux Agaricaceae, s'ajoutent cinq genres, *Crucispora* et *Micropsalliota* dans les Agariceae, *Dissoderma, Verrucospora* et *Squamanita* dans les Cystodermateae.

Aux Bolbitiaceae, s'ajoutent *Pseudoconocybe* et *Descolea* (des Cortinariaceae). Aux Strophariaceae, s'ajoute *Phaeomarasmius* (aussi des Cortinariaceae). Les Cortinariaceae perdent encore *Simocybe* et *Melanomphalia* qui passent aux Crepidotaceae; et dans celles-ci *Merismodes* est reconnu.

L'auteur s'est efforcé de présenter des synonymies complètes des genres et des taxas supérieurs. Il mentionne aussi un plus grand nombre d'especes mais renvoie le lecteur aux monographies existantes pour les clés de détermination.

L'auteur a aussi augmenté son introduction et son illustration des acquisitions récentes sur la microscopie électronique des Agaricales.

CORTINARIUS FR. UND NAHE VERWANDTE GATTUNGEN IN SUDAMERIKA, by Meinhard MOSER and Egon HORAK, 628 p., with 9 text-figs., 116 pl. with 677 line-drawing figs., 20 pl. with 134 col. aquarelles. Beihefte zur Nova Hedwigia 52, 1975, ed. J. Cramer, FL-9490 Vaduz, Liechtenstein. DM 250.-

The present book is an important contribution to the taxonomy of *Cortinarius* and related genera gained by the authors from their collecting trips through South America, from Colombia to Argentina, in 1963, in areas characterized by the most typical vegetation, i.e., *Quercus, Alnus, Nothofagus, Eucalyptus* and *Salix*. It provides critical descriptions and excellent illustrations of not less than 296 new species in *Cortinarius, Dermocybe* (as a genus), *Rozites* and the new genus *Stephanopus*. Spegazzini's species have been revised as a preliminary. Keys to genera, subgenera, sections, stirps and species are given both in English and in German. The chromatography of the pigments in some species of *Cortinarius* and *Dermocybe,* contributed by Isle Gruber, has allowed the elaboration of a kind of chemotaxonomy of the species studied.

Anyone interested in the taxonomy of this group, in mycorrhizal fungi or in the world mycoflora will have to refer to this book.

The authors dedicate the book to Dr. Rolf Singer on the occasion of his 70th birthday and acknowledge his great contribution to the success of their project.

(continued on page 486)

MYCOTAXON

Vol. III, No. 3, pp. 397-400 April-June 1976

A NOMENCLATURAL NOTE CONCERNING *SARCINOMYCES* LINDNER AND *SARCINOMYCES* OHO

S. C. JONG and D. S. KING

Mycology Department, American Type Culture Collection
12301 Parklawn Drive, Rockville, Maryland 20852

SUMMARY

Sarcinomyces Oho in Ota, 1926 (Cryptococcaceae), is a later homonym of *Sarcinomyces* Lindner, 1898 (Dematiaceae). The former is an obligate synonym of *Sarcinosporon* King & Jong, 1975, and the latter is a facultative synonym of *Aureobasidium* Vials & Boyer, 1891.

Sarcinomyces Lindner, validly published in Mikrosk. Betriebscontr. 2: 228, 1898, was erected for a single species *S. crustaceus* Lindner. He later added the second species *S. albus* Lindner (1901) to the genus. The genus was assigned to the Dematiaceae of the Moniliales. Saccardo (1906) and Clements and Shear (1931) erroneously quoted Mikrosk. Betriebscontr. 3: 300, 1901, as the valid publication of the genus. Cooke (1959) considered both *S. crustaceus* and *S. albus* to be synonyms of *Aureobasidium pullulans* (de Bary) Arnaud, and therefore *Sarcinomyces* Lindner becomes a facultative synonym of *Aureobasidium* Vials & Boyer. This taxonomic treatment is accepted in the *Dictionary of the Fungi* (Ainsworth, 1971) and by Kendrick and Carmichael (1973).

In 1919 Oho described a fungus isolated from skin scrapings from scrotal dermatoses frequently found in young males in Formosa. The lesion was reproduced experimentally on a human volunteer by inoculation with an isolate of the fungus. Although Oho mentioned the name *Microsoporon brachytomum* in reference to the fungus he described, he indicated that this name was only provisional. We consider that *M. brachytomum* is not validly published per Article 34 of the International Code of Botanical Nomenclature.

Apparently, Ota (1926) was not aware of *Sarcinomyces* Lindner and proposed the generic name *Sarcinomyces* Oho to accommodate Oho's fungus as *Sarcinomyces inkin* Oho. It was clearly stated in Ota's publication that he gave credit to Oho for the new genus and species; this fact has been overlooked by subsequent workers (Mesones and Dodge, 1960; Carmo-Sousa and van Uden, 1967; Carmo-Sousa, 1970; King and Jong, 1975), probably because Ota's publication was in Japanese. They all erroneously cited Oho's original publication, Kyoto Igaku Zasshi 16: 15, 1919, as the place and date of valid publication of the fungus and interpreted it as a member of *Sarcinomyces* Lindner. In fact, there is no connection between *Sarcinomyces* Lindner and *Sarcinomyces* Oho.

Sarcinomyces inkin Oho was later transferred to *Trichosporon* Behrend as *T. inkin* (Oho) Carmo-Sousa & van Uden (1967). Recently King and Jong (1975) created a new genus *Sarcinosporon* to accommodate *Trichosporon inkin* as *S. inkin* (Oho) King & Jong. They also proposed *Prototheca filamenta* Arnold & Ahearn (1972) to be a synonym of *S. inkin*. That the type strain ATCC 22432 of *P. filamenta* is indeed a fungus has been confirmed by Nadakavukaren and McCracken (1975) using scanning and transmission electron microscope observations. Although *Sarcinomyces* Oho has priority over *Sarcinosporon* King & Jong, the former is a later homonym of *Sarcinomyces* Lindner. Therefore, the correct nomenclator is as follows:

Sarcinosporon King & Jong, Mycotaxon 3: 92, 1975

≡ *Sarcinomyces* Oho in Ota, Japanese J. Derm. Urol. 26: 111, 1926 (*non Sarcinomyces* Lindner, 1898)

Sarcinosporon inkin (Oho) King & Jong, Mycotaxon 3: 93, 1975

≡ *Sarcinomyces inkin* Oho in Ota, Japanese J. Derm. Urol. 26: 111, 1926

≡ *Trichosporon inkin* (Oho) Carmo-Sousa & van Uden, Mycologia 59: 653, 1967

= *Prototheca filamenta* Arnold & Ahearn, Mycologia 64: 270, 1972.

This work was supported in part by National Science Foundation Grant No. DEB75-06286 A01.

LITERATURE CITED

AINSWORTH, G. C. 1971. *Ainsworth & Bisby's Dictionary of the Fungi.* 6th ed. Commonwealth Mycological Institute, Kew, Surrey. 663 pp.

ARNOLD, P., and D. G. AHEARN. 1972. The systematics of the genus *Prototheca* with description of a new specie species *P. filamenta.* Mycologia 64: 265-275.

CARMO-SOUSA, L. DO. 1970. *Trichosporon* Behrend. p. 1309-1352. *In* J. Lodder (ed.), *The Yeasts..* North Holland Publishing Co., Amsterdam.

CARMO-SOUSA, L. DO, and N. VAN UDEN. 1967. Reisolation of *Sarcinomyces inkin* and its transfer to the genus *Trichosporon.* Mycologia 59: 653-657.

CLEMENTS, F. E., and C. L. SHEAR. 1931. *The Genera of Fungi.* H. W. Wilson Co., New York. 496 pp.

COOKE, W. B. 1959. An ecological life history of *Aureobasidium pullulans* (de Bary) Arnaud. Mycopathol. Mycol. Appl. 12: 1-45.

KENDRICK, W. B., and J. W. CARMICHAEL. 1973. Hyphomycetes. p. 323-509. *In* G. C. Ainsworth, F. K. Sparrow, and A. S. Sussman (eds.), *The Fungi.* Vol. IVA. Academic Press, New York.

KING, D. S., and S. C. JONG. 1975. *Sarcinosporon:* a new genus to accommodate *Trichosporon inkin* and *Prototheca filamenta.* Mycotaxon 3: 89-94.

LINDNER, P. 1898. Mikroskopische Betriebscontrole in der Gahrungswerben mit einer Einfuhrung in die Hefereinculture, Infectionslhre und Hefenkunde. Ed. 2. 365 pp.

LINDNER, P. 1901. Mikroskopische Betriebscontrole in der Gahrungswerben mit einer Einfuhrung in die Hefereinculture, Infectionslhre und Hefenkunde. Ed. 3. 468 pp.

MESONES, H. A., and C. W. DODGE. 1960. *Sarcinomyces inkin* in Brasil. Mycologia 52: 800-804.

NADAKAVUKAREN, M. J., and D. A. McCRACKEN. 1975. *Prototheca filamenta:* a fungus not an alga. Mycopathologia 57: 89-91.

OHO, O. 1919. Ueber das sogenannte "Inkin." Kyoto Igaku Zasshi 16: 7-21.

OTA, M. 1926. Champignons parasites de l'homme. Japanese J. Derm. Urol. 26: 111-142.

SACCARDO, P. A. 1906. *Sylloge fungorum omnium hucusque cognitorum*. Vol. 18. Supplementum universale. Pars VII. Discomycetae-Deuteromycetae. Patavii. 838 pp.

MYCOTAXON

Vol. III, No. 3, pp. 401-408 April-June 1976

ACICULOCONIDIUM: A NEW HYPHOMYCETOUS GENUS TO ACCOMMODATE *TRICHOSPORON ACULEATUM*

D. S. KING and S. C. JONG

Mycology Department, American Type Culture Collection
12301 Parklawn Drive, Rockville, Maryland 20852

SUMMARY

A new genus *Aciculoconidium* and a new combination *A. aculeatum* are proposed to accommodate *Trichosporon aculeatum* Phaff *et al.* The fungus is characterized by filamentous growth and blastoconidia budding singly or successively in chains as in the genus *Candida* and by the production of needle-shaped conidia which terminate the development of spores on the hyphae. Conidia may germinate to produce either the filamentous phase or the yeast phase.

In the course of current investigations into the systematics of the imperfect genus *Trichosporon* Behrend, subcultures of the type strain of *T. aculeatum* Phaff *et al.* (1956) were examined morphologically and nutritionally. Phaff *et al.* figured the needle-shaped cells which distinguish this species but did not describe their function. They also figured individual hyphal segments which they considered arthroconidia. It was due to the latter, as well as true mycelium and blastoconidia, that this fungus was placed in *Trichosporon*. Hedrick and Dupont (1968) and Carmo-Sousa (1970) accepted this species in *Trichosporon*. These workers thus accepted the presence of arthroconidia in this fungus, and Carmo-Sousa figured individual hyphal segments similar to those figured by Phaff *et al.* (1956).

The purposes of this paper are to present morphological observations showing that the needle-shaped cells of this species are holoblastic conidia and to erect a new genus to accommodate this unique fungus.

METHODS AND MATERIALS

Cultures. Two subcultures of the type strain isolated by Phaff *et al.* (1956) were examined. ATCC 15540 (NRRL YB4297) was deposited in the American Type Culture Collection (ATCC) by P. DuPont and L. Hedrick in July 1964. ATCC 28680 was deposited by L. do Carmo-Sousa in the Centraalbureau voor Schimmelcultures (CBS) as CBS 5578, and obtained by the ATCC from CBS in February 1975.

Morphology: Media used were CM (Difco corn meal agar), 1/2 CM (1/2 X Difco corn meal agar), GYEP (2% dextrose, 1% Difco peptone, 0.5% Difco yeast extract, with 1.5% Difco agar for solid media), YM (Difco yeast malt agar and broth), MA (Difco malt agar), PDA (500 g potatoes, infusion from 20 g dextrose, 15 g agar, 1 liter distilled water) and M40Y (2% Difco malt extract, 0.5% Difco yeast extract, 40% sucrose, 2% Difco agar). All cultures were incubated at room temperature (22±2 C).

Slide cultures on CM and GYEP agars were examined at 4 and 7 days. Dalmau cultures on the same media were examined at 4 and 7 days, and at intervals up to 30 days. Additional cultures were grown on 1/2 CM, MA, YM, PDA and M40Y agars to observe variation in morphology. These were examined periodically from 1 to 14 days following inoculation. Cultures in YM broth in cotton plugged flasks were examined 2 and 4 days after inoculation for observation of growth in liquid culture.

Physiology: For inoculations in all physiological tests, the growth after 2 days on 5 ml of YM agar slanted in a test tube was aseptically scraped off and suspended in 6.5 ml of sterile distilled water, and the suspended cells drawn into a sterile disposable syringe equipped with a 20 gauge needle. Each tube of test medium was inoculated with one drop of the suspension. All cultures were incubated at room temperature (22±2 C).

Carbon assimilation media were similar to those of Wickerham (1951). All sources (see TABLE I) were used at 0.5% in 5 ml of Difco yeast nitrogen base in duplicate test tubes, except raffinose at 1.0%. The pH of all media (including organic acid media) was unadjusted. Cultures were evaluated for presence or absence of growth over a 30-day period of incubation.

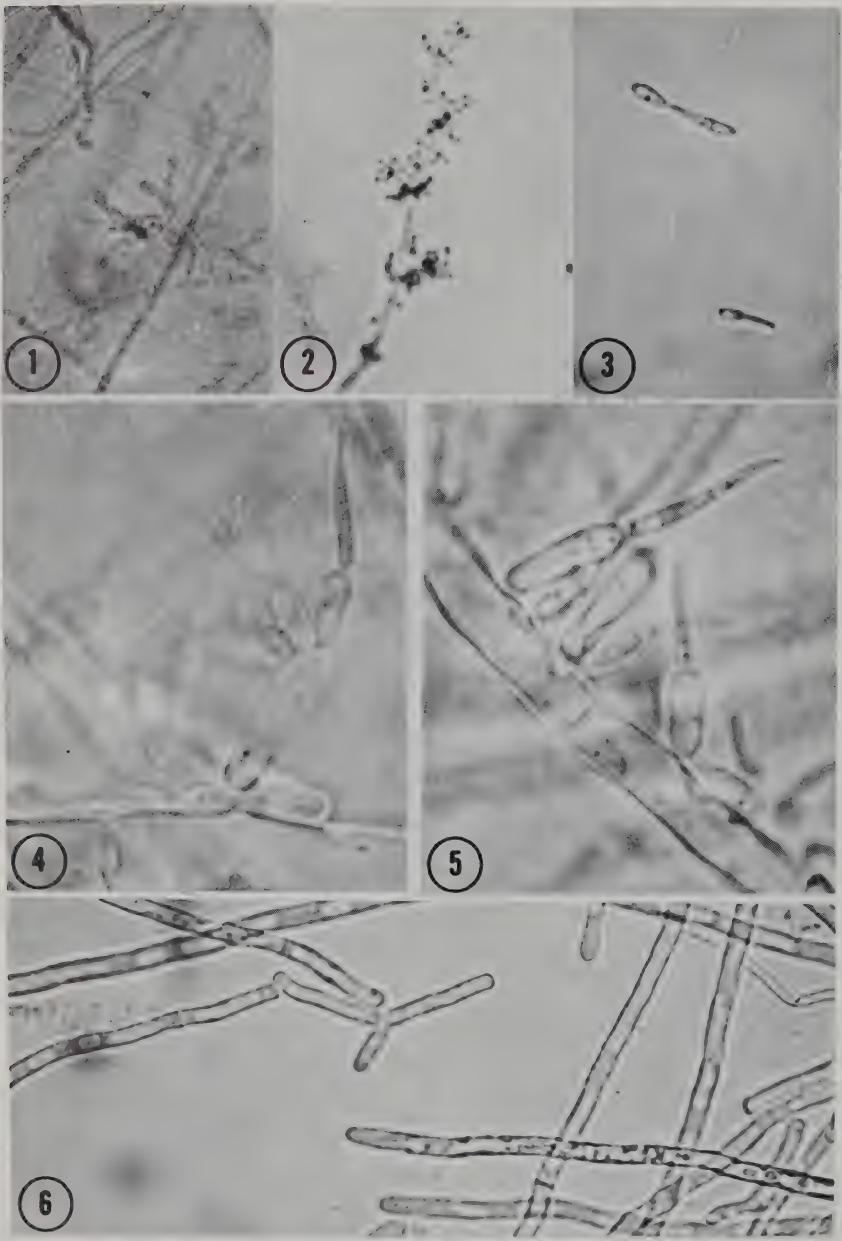
For each nitrogen source, duplicate tubes of 5 ml Difco yeast carbon base with the nitrogen source were inoculated and after 10 days, 1-3 drops from this set were used to inoculate a second set of tubes. The second set contained a basal medium of salts plus vitamins (KH_2PO_4, 1 g; $MgSO_4 \cdot 7H_2O$, 0.5 g; $FeCl_3$, 0.6 mg; $ZnSO_4 \cdot 7H_2O$, 0.9 mg; $MnSO_4 \cdot 1H_2O$, 0.3 mg; biotin, 5 µg; thiamine, 100 µg; distilled water, 1 liter) and the nitrogen source. The second set of tubes were examined for growth 10 days after inoculation. Nitrogen sources and quantities used were: KNO_3, 0.78%; $NaNO_2$, 0.26%; ethylamine HCl, 0.64%; and as a positive control, NH_4NO_3, 1.0%.

As a test for vitamin-free growth, duplicate tubes of Difco vitamin-free yeast base were inoculated and after 10 days, a second set of tubes containing the salts basal medium and NH_4NO_3 (but without added vitamins) was inoculated from the first set and examined for growth after 10 days.

Duplicates of GYEP agar slanted in test tubes were inoculated and examined for growth after incubation for 4 days at 30 and 37 C. Duplicate tubes of arbutin medium (arbutin, 1.25%; yeast extract, 1.25%; ferric ammonium sulfate, 0.125%; agar, 1.0%) were inoculated and incubated at room temperature, then examined after 10 days for darkening. Duplicate tubes of urea medium (Difco urea agar base, pH adjusted to 6.8; 1.5% agar) were inoculated and incubated at room temperature, then examined after 10 days for reddening. Cultures on YM agar in Petri dishes were smelled after 2 days to detect distinctive odors.

RESULTS AND DISCUSSION

Both strains were morphologically identical. A very rapid, coarse, spreading growth was produced on all solid



Figs. 1-6. *Aciculoconidium aculeatum*. 1. ATCC 28680, chains of blastoconidia on malt agar, 8 da, ca. X 700. 2-6. ATCC 15540. 2. Blastoconidia on malt agar, 8 da,

TABLE I

PHYSIOLOGICAL TEST RESULTS

ATCC Strain	15540	28680	ATCC Strain	15540	28680
Glucose	+	+	Adonitol	+	+
Galactose	-	-	Dulcitol	-	-
L-sorbose	-	-	D-mannitol	+	+
Maltose	+	+	D-sorbitol	+	-
Sucrose	+	+	α-methyl-D-glucoside	+	+
Cellobiose	+	+	Salicin	+	+
Trehalose	+	+	Inositol	-	-
Lactose	-	-	Lactic acid	-	-
Melibiose	-	-	Citric acid	+	+
Raffinose	-	-	Succinic acid	+	+
Melezitose	+	+	Valine	-	-
Inulin	-	-	Glycine	-	-
Soluble Starch	+	+	Proline	+	+
D-xylose	-	-	Arginine	+	-
L-arabinose	-	-	Nitrate	-	-
D-arabinose	-	-	Nitrite	-	-
D-ribose	-	-	Ethylamine HCl	+	+
L-rhamnose	-	-	Growth at 30 C	+	+
D-glucosamine	+	+	Growth at 37 C	-	-
Ethanol	+	+	Arbutin splitting	+	+
Glycerol	+	-	Urease	-	-
i-erythritol	-	-			

ca. X 310. 3. Needle-shaped conidia germinating to produce a blastoconidium in ethylamine nitrogen assimilation medium, 5 da, ca. X 840. 4-5. Needle-shaped conidia borne on conidiogenous blastoconidia on 1/2 X cornmeal, 2 da, ca. X 1750. 6. Hyphal segments disarticulating in young culture in yeast malt broth, 1 da, ca. X 340.

media. Microscopically, blastoconidia were borne laterally on septate hyphae (Figs. 1 & 2). Developmentally, the blastoconidia either become detached and subsequently reproduce by budding, or produce other blastoconidia in situ, giving rise to short chains (Fig. 1); or give rise to one or more (up to 4) needle-shaped conidia (Figs. 4 & 5). Although the blastoconidia produced on the hyphae may become detached and act as propagules, production of the needle-shaped conidia terminates their development on the hyphae. Also, the needle-shaped conidia do not germinate until they become detached (Fig. 3). The blastoconidia therefore become conidiogenous cells which produce the needle-shaped conidia.

Very large segments of hyphae distinctive in their development were observed on all media (Fig. 6). In some hyphae disarticulation occurs beginning at the proximal end. Distinct chains of arthroconidia typical of the genus *Geotrichum* are therefore not observed. This pattern of disarticulation is a common phenomenon in filamentous fungi in culture. The individual hyphal segments observed in this fungus thus should not be considered conidia.

The two strains differed somewhat in utilization of carbon sources. They did agree in all other physiological tests. Both strains produced a very strong fruity, aromatic odor on YM agar, and failed to grow on vitamin-free medium. ATCC 15540 had a carbon assimilation pattern identical to that given by Phaff *et al.* (1956) and Carmo-Sousa (1970) in the standard description of *Trichosporon aculeatum*. ATCC 28680 deviated from the pattern of ATCC 15540 in failing to utilize arginine, sorbitol, and glycerol.

Physiological change has been noted in cultures maintained in tube cultures and in the freeze-dried state (Wellman and Stewart, 1973; Scheda and Yarrow, 1966). The possibility of change in ATCC 28680 in the freeze-dried state therefore cannot be excluded. Preservation in the frozen state in liquid nitrogen is probably the most preferable method of long-term preservation to reduce the probability of change during maintenance, as well as the best means of preserving viability over a long period.

This species cannot be retained in the genus *Trichosporon* because the needle-shaped holoblastic conidia are prominant, and there is no production of arthroconidia of the *Geotrichum* type that is associated with the genus *Trichosporon*. Since it does not agree with any previously described hyphomycetous genus, we are erecting a new genus.

Aciculoconidium King et Jong, gen. nov.

Fungus hyalinus cum cellulis gemmiferis, mycelia et blastoconidia. Mycelium e hyphis ramosis, septatis compositum. Blastoconidia catenata, continua, ellipsoideae vel subglobosae; conidia terminalis aculeata. Species typica: *A. aculeatum*.

Fungus hyaline, with budding cells, mycelia and blastoconidia. Mycelium composed of branched, septate hyphae. Blastoconidia catenulate, *Candida*-like, subspherical to ellipsoid; terminal conidia needle-shaped, rounded at the proximal end and pointed at the distal end. Hyphomycetes, Fungi Imperfecti.

Aciculoconidium aculeatum (Phaff *et al.*) King *et* Jong, comb. nov.

≡ *Trichosporon aculeatum* Phaff *et al.*, Antonie van Leeuwenhoek 34: 160, 1956.

Growth on agar media primarily filamentous with regular septa and with usually monopodial branching. Conidia holoblastic, unicellular, hyaline, borne singly or successively in chains similar to *Candida*, subspherical to ellipsoid, 2.5-3.5 X 3.5-8.0 µm, terminated by production of needle-shaped spores which are rounded at the proximal and pointed at the distal end, 0.5-2.0 X 5.5-21.5 µm. Conidia germinating on a variety of media, producing budding yeast cells, 2.0-3.5 X 3.0-7.0 µm.

The type strain ATCC 15540, originally isolated by Phaff *et al.* (1956) from *Drosophila pinicola* near Mather, California, is preserved by being frozen and stored in liquid nitrogen at -196 C at the ATCC. The lectotype, a dried cornmeal agar plate culture of this strain, has been deposited in the herbarium of the National Fungus Collections, Beltsville, Maryland.

ACKNOWLEDGMENTS

This work was supported in part by National Science Foundation Grant DEB75-06286 A01 and by Brown-Hazen Grant BH 846 from Research Corporation, New York.

LITERATURE CITED

CARMO-SOUSA, L. DO. 1970. *Trichosporon* Behrend. p. 1309-1352. *In* J. Lodder (ed.), *The Yeasts, a Taxonomic Study*. North-Holland Publishing Co., Amsterdam.

HEDRICK, L. R., and P. D. DuPONT. 1968. The utilization of L-amino acids as carbon source by yeasts of the genera *Hansenula* and *Trichosporon*. Antonie van Leeuwenhoek 34: 465-473.

PHAFF, H. J., M. W. MILLER, and M. SHIFRINE. 1956. The taxonomy of yeasts isolated from *Drosophila* in the Yosemite region of California. Antonie van Leeuwenhoek 22: 145-161.

SCHEDA, R., and D. YARROW. 1966. The instability of physiological properties used as criteria in the taxonomy of yeasts. Arch. Mikrobiol. 55: 209-225.

WELLMAN, A. M., and G. G. STEWART. 1973. Storage of brewing yeasts by liquid nitrogen refrigeration. Appl. Microbiol. 26: 577-583.

WICKERHAM, L. J. 1951. *Taxonomy of yeasts*. Tech. Bull. U. S. Dep. Agric. No. 1029.

MYCOTAXON

Vol. III, No. 3, pp. 409-485 April-June 1976

CONTRIBUTION TO THE KNOWLEDGE OF *STACHYBOTRYS* AND *MEMNONIELLA* IN CULTURE

S. C. JONG and E. E. DAVIS

Mycology Department, American Type Culture Collection
12301 Parklawn Drive, Rockville, Maryland

ABSTRACT

Members of *Stachybotrys* and *Memnoniella* are morphologically and physiologically closely related and are of worldwide distribution. Many of them are commonly isolated from soil and are capable of utilizing cellulose and damaging fabrics made of plant fibers. Cultures of *Stachybotrys chartarum* and *Memnoniella echinata* have been used for fungus resistance tests in U. S. and British military specifications. Strains of *S. chartarum* are also known to produce toxic compounds which have been reported as agents of stachybotryotoxicosis in animals and man. The toxicants belong to the series of sesquiterpenoid mycotoxins classified as 12,13-epoxy-Δ^9-trichothecenes. The salient feature both genera have in common is the production of macronematous conidiophores with an apical cluster of several unicellular conidiogenous cells bearing unicellular enteroblastic-phialidic conidia. The main difference between *Stachybotrys* producing slimy heads of conidia and *Memnoniella* producing chains of conidia is in the length of time between formation of the septum in the phialide neck and its splitting when the conidia separate. In *Stachybotrys* the new conidia arise after previous ones are mature and released from the phialide neck, whereas in *Memnoniella* the

new conidia arise in basipetal succession before the previous ones are mature. In the present study fifty strains currently maintained in the American Type Culture Collection (ATCC) were characterized and reidentified to the following species: *Stachybotrys albipes*, *S. bisbyi*, *S. chartarum*, *S. cylindrospora*, *S. dichroa*, *S. kampalensis*, *S. microspora*, *S. nephrospora*, *S. oenanthes*, *S. parvispora*, *S. theobromae*, *Memnoniella echinata*, *M. subsimplex*. Each species treated has been redescribed and illustrated. A key is constructed to facilitate the identification of these cultured species. The shape, size and the color and ornamented surface of phialoconidia are principally used to distinguish the species. Two new combinations, *Stachybotrys albipes* (Berk. & Br.) Jong & Davis and *S. microspora* (Mathur & Sankha) Jong & Davis, are proposed. *Stachybotrys sacchari* (Srinivasan) Barron is recommended as a synonym of *S. bisbyi* (Srinivasan) Barron, and *S. reniformis* Tubaki and *S. sinuatophora* Matsushima are synonyms of *S. nephrospora* Hansford.

TABLE OF CONTENTS

INTRODUCTION 412
HISTORICAL TREATMENT OF THE GENERA 413
ECONOMIC SIGNIFICANCE 415
PHYSIOLOGICAL CHARACTERS 417
MORPHOLOGY AND DEVELOPMENT 419
PERFECT STATE 422
KEY TO THE SPECIES IN CULTURE 423
DESCRIPTIONS AND ILLUSTRATIONS 425
    Stachybotrys albipes 425
    Stachybotrys bisbyi 430
    Stachybotrys chartarum 433
    Stachybotrys cylindrospora 440
    Stachybotrys dichroa 442
    Stachybotrys kampalensis 447
    Stachybotrys microspora 448
    Stachybotrys nephrospora 453
    Stachybotrys oenanthes 455
    Stachybotrys parvispora 459
    Stachybotrys theobromae 460
    Memnoniella echinata 464
    Memnoniella subsimplex 471
ACKNOWLEDGMENTS 474
LITERATURE CITED 475

INTRODUCTION

The Hyphomycetes, grouped together because of similarities in their morphological appearance, belong to a specially classified group known as the Fungi Imperfecti. The incomplete type of life cycle in the imperfect fungi is identical with the asexual states of the Ascomycetes or of the Basidiomycetes. Ideally, the scientific names of imperfect (asexual) fungi should be discarded and replaced by the names of their perfect (sexual) states according to the natural system. However, some of the imperfect species, recognized as playing important roles in agriculture, industry, medicine and environment, have never been detected in their perfect states. They are among the most common of aquatic and soil fungi. The Hyphomycetes especially are abundant everywhere, many of them being pathogenic to plants, animals and humans. Accordingly, Fungi Imperfecti cannot be disregarded, and they are grouped exclusively in the class Deuteromycetes, which has long been classified independently of the Ascomycetes and the Basidiomycetes.

The necessity of living cultures for characterizing, identifying, and classifying the Hyphomycetes has been emphasized in recent years by the application of new taxonomic criteria related to the nature of conidiogenous cells and the precise method by which conidia are produced (Hughes, 1953; Goos, 1956; Simmons, 1966; Barron, 1968; Tubaki, 1958; Kendrick, 1971; Kendrick & Carmichael, 1973). Although Barron (1968) and Kendrick and Carmichael (1973) have recently applied the new scheme of classification to nearly 600 genera of Hyphomycetes and Ellis (1971a) has provided modern descriptions and illustrations of the common dematiaceous Hyphomycetes, our present knowledge of the new taxonomic criteria still has not come close to satisfying our need in identification of unknown Hyphomycetes. Therefore, much confusion has resulted in the modern literature, when, at different times, mycologists have set up new genera and new species based on different sets of criteria, e.g., superficial or developmental characters, or combinations of both. It is also difficult to correlate the original descriptions in the classical literature with the new scheme because most of them are hopelessly inadequate and without any indication of the method of conidial production. For these reasons, difficulties in determining the identities of Hyphomycetes in culture are frequently encountered by us in our routine curatorial work at the American Type Culture Collection (ATCC).

The specific aims of the project are: (1) to study as many strains as possible of selected genera of Hyphomycetes which are presently available from reliable culture collections; (2) to determine the identity and morphological variability of each strain and to utilize the results as a basis for resolving the formidable nomenclatural problems associated with Hyphomycetes in culture and in nature; (3) to describe and illustrate the species examined in culture so as to evaluate the more detailed microscopic characters used as criteria in the new scheme of classification; and (4) to construct a key to facilitate the identification of cultured species on a genus by genus approach.

The descriptions, illustrations and keys which result from these studies will be extremely useful in identifying Hyphomycetes in culture, especially those isolated from such materials as soil, water, humans, animals and plants. The present report deals with the genera *Stachybotrys* and *Memnoniella*.

HISTORICAL TREATMENT OF THE GENERA

The imperfect genus *Stachybotrys* was proposed by Corda (1837) for a single species *S. atra* Corda. He described the genus as follows: "Stipes septus, ramosus; ramis apice ramulis verticillatis, mamillaribus, brevissimis, capitulum formantibus corematis; sporis didymis, homogenesis regulariter postis et capitulo innatis."

A detailed review of the earlier literature of the genus has been presented by Bisby (1943). From critical studies of cultures and herbarium specimens, he emended the genus as having the "Hyphae, phialophores, and phialides hyaline, brightly colored, or dark; strands or ropes of hyphae may be produced. Conidia (slime-spores) one-celled, normally dark and accumulating into a cluster." At that time there were over twenty species proposed in the literature, but Bisby reduced them to two distinct species, viz., *S. atra* and *S. subsimplex* Cooke. The type species *S. atra* was later identified by Hughes (1958) with *Stilbospora chartarum* Ehrenberg ex Link. *Synsporium* Preuss was considered by Hughes as a synonym of *Stachybotrys*.

Fuckelina Saccardo (1875) was created to accommodate the conidial state of *Eriosphaeria raripila* Sacc. as *F. socia* Sacc. Saccardo (1878) later identified *E. raripila* with *Melanopsamma pomiformis* (Pers. ex Fr.) Sacc.; and Ferraris (1909) transferred *F. socia* to *Stachybotrys* as *S. socia* (Sacc.) Sacc.

Gliobotrys Höhnel (1902) was erected for a *Stachybotrys*-like species with hyaline conidiophores and conidia olivaceous in masses. The type species *G. alboviridis* Höhnel was later identified by Höhnel (1923) as the conidial state of *Melanopsamma pomiformis* (Booth, 1957). Therefore, *Fuckelina* and *Gliobotrys* must be synonyms and should be considered under *Stachybotrys*.

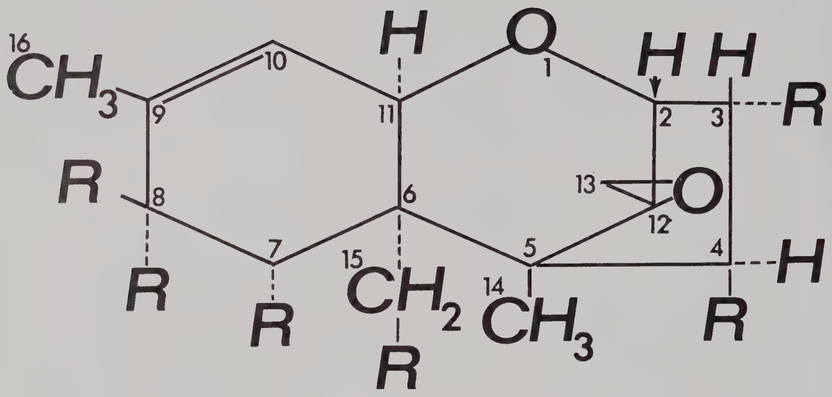
Hyalostachybotrys was established by Srinivasan (1958) to include two hyaline *Stachybotrys*-like fungi. Barron (1964) believed that a genus based on color of the conidia would have no taxonomic validity, and suggested that *Stachybotrys* should include not only the dematiaceous species but also the hyaline forms. He therefore reduced *Hyalostachybotrys* to synonymy with *Stachybotrys*.

The genus *Memnoniella* was erected by Höhnel (1923) to include those fungi which have the conidiophores with an apical cluster of several swollen phialides resembling those of *Stachybotrys* and the black phialoconidia borne in long chains recalling those of *Aspergillus niger* van Tieghem (Galloway, 1933). Although Zuck (1949) found that some isolates of the type species *M. echinata* (Rivolta) Galloway might occasionally produce a *Stachybotrys*-like phase in culture much like the description of *S. subsimplex sensu* Bisby (1943), he considered *Memnoniella* and *Stachybotrys* to be distinct genera. The morphological distinction between these two genera is the disposition of conidia which are in long chains in *Memnoniella* and in slimy masses in *Stachybotrys*. Nevertheless, Smith (1962) considered this distinction not sufficient to warrant separation of the two genera and transferred *M. echinata* to *Stachybotrys*. Kendrick and Carmichael (1973) recently accepted Smith's taxonomic treatment, though the arrangement of conidia was used by them as one of the four independent character sets to characterize and order the hyphomycetous genera for identification. On the other hand, Padwick (1945), Deighton (1960), Matsushima (1971a,b; 1975) and Ellis (1971a) recognized *Memnoniella* as being distinctive from *Stachybotrys*. The culture of the *Memnoniella* examined in the course of the present study remain stable in the characters distinguishable from *Stachybotrys*, therefore we also consider the two genera to be distinct taxa.

ECONOMIC SIGNIFICANCE

Members of *Stachybotrys* and *Memnoniella* are of worldwide distribution. Many of them are commonly found in soil and are capable of utilizing cellulose and damaging fabrics made of plant fibers. Cultures of the species *S. chartarum* and *M. echinata* have been used for fungus resistance tests in U. S. and British military specifications. Strains of *S. chartarum* (syn. *S. atra*, *S. alternans*) are also known to produce mycotoxins which have been reported as agents of stachybotryotoxicosis in animals and man (Gray, 1971; Rodricks & Eppley, 1974).

According to Forgacs (1965, 1972), stachybotryotoxicosis was first reported in horses from the Ukrainian S.S.R. in 1931. At that time it caused the death of thousands of horses in the Soviet Union. This disease has since been discovered to affect both animals and man, causing cutaneuous and mucosal necrosis. It also may bring about leukopenia and agranulocytosis, and may finally affect the heart, causing standstill in systole (Forgacs, 1972; Palyusik, 1970a). The *Stachybotrys* toxins as a group contain certain compounds in common, but they differ somewhat in their chemical structures and biological effects (Korpinen *et al.*, 1974). They belong to the series of sesquiterpenoid mycotoxins classified as 12,13-epoxy-Δ^9-trichothecenes (Eppley & Bailey, 1973). The following formula shows the structural features of these toxicants.



The toxic compounds can be obtained from oat cultures as well as from synthetic agar cultures of *S. chartarum* by extraction with diethyl ether in a Soxhlet apparatus (Forgacs & Carll, 1962; Palyusik, 1970a, Korpinen & Ylimaki, 1972; Eppley & Bailey, 1973). The degree of toxicity varies in different strains (Forgacs *et al.*, 1958; Palyusik, 1970a; Korpinen & Uoti, 1974). In addition to *S. chartarum*, the fungi which have been shown capable of elaborating 12,13-epoxy-Δ^9-trichothecenes include *Cephalosporium crotocinigenum, Fusarium concolor, F. equiseti, F. nivale, F. scirpi, F. tricinctum, Gibberella zeae, Myrothecium roridum, M. verrucaria, Trichoderma viride,* and *Trichothecium roseum* (Bamburg & Strong, 1971; Wilson, 1973). These naturally occurring members of the trichothecenes are colorless, crytalline, optically-active solids with low water solubility. They are chemically quite stable when stored under laboratory conditions and are not destroyed by usual cooking procedures (Bamburg & Strong, 1971). A toxic substance extracted from a strain of *S. chartarum* was found to be cytotoxic even at lower concentrations than aflatoxin B_1 (Bodon & Palyusik, 1970).

Feed contaminated with *S. chartarum* is the main source of the agent causing stachybotryotoxicosis in animals. Under field conditions, toxicosis can affect horses, cattle, hens, hippopotamus, bison, sheep, buffaloes, swine and poultry (Palyusik, 1970a; Rodricks & Eppley, 1974). Stachybotryotoxicosis may occur in man exposed to the fungus (Drobotko, 1945). The toxins are said to be absorbed through the skin and by inhalation, and illness may follow exposure from the handling or burning of hay molded by the fungus (Emmons *et al.*, 1970; Rodricks & Eppley, 1974).

PHYSIOLOGICAL CHARACTERS

Marsh and Bollenbacher (1946) showed that *S. chartarum* (as *S. atra*) and *M. echinata* were similar in many physiological characteristics, including the ability to grow on synthetic medium containing only biotin, glucose and inorganic salts. Perlman (1948) and Jermyn (1953) further confirmed their conclusions, and found that both fungi can utilize some twenty sugars and sugar derivatives as sole sources of carbon for growth. Growth was increased with the addition of traces of iron, zinc or manganese to the medium but was decreased with the addition of nickel, cobalt, chromium or aluminum.

Biotin deficiency was reported to be characteristic of *M. echinata* and *S. chartarum* (Marsh & Bollenbacher, 1946; Perlman, 1948). The absolute requirement of biotin was usually less than 5 µg per liter. However, the presence of aspartic acid in the culture medium was shown to reduce the amount of biotin required (Perlman, 1948). Lilly and Barnett (1951) noted that the variability of cellulolytic activity in strains of *M. echinata* in laboratory tests was possible correlated with biotin deficiency. The relationship between the amounts of sugar and biotin necessary for sporulation was described by Buston and Basu (1948). Less biotin was required for vegetative growth than for sporulation. Sporulation was conditioned by the concentrations of biotin and of the sugars present.

Perlman (1951) reported that *M. echinata* required biotin for spore germination. Growth from a spore inoculum required biotin, which was not replaceable by desthiobiotin. However, if desthiobiotin was added to a growing culture supplied with limiting amounts of biotin, the desthiobiotin elicited a significant growth response. Since the mycelium is able to convert desthiobiotin to biotin but the spore cannot, the spore germination is affected by growth factor deficiencies (Cochrane, 1958).

Cultural studies done by Barron (1962) also indicated that *S. bisbyi* (as *S. aurantia*) had a rapid growth rate and, on a minimal synthetic medium, required a biotin supplement for normal growth, as reported in both *S. chartarum* and *M. echinata*.

Stachybotrys chartarum was found to synthesize humic acid-type polymers (Martin & Haider, 1969). The amino acid composition of *S. chartarum* humic acid was reported to be similar to that of soil humic acids (Ortiz de Serra *et al.*, 1973). Additions of a small amount of clay minerals, especially montmorillonite, to well-aerated cultures of this fungus greatly accelerated growth, glucose utilization, CO_2 evolution, phenol synthesis, and phenolic polymer formation (Filip *et al.*, 1972a,b). Nitrate-N was a poor nitrogen source for *S. chartarum*, but was a relatively good source of N in the presence of montmorillonite (Bordietti *et al.*, 1971).

Memnoniella echinata was reported to form acetic acid from carbohydrates (Perlman, 1951).

In tests of the microbiological deterioration of cellulosic fibers, a few strains of *S. chartarum* and *M. echinata* were found to be definitely active (Thom *et al.*, 1934; Greathous *et al.*, 1942; White *et al.*, 1948, 1949; Marsh *et al.*, 1949; Reese *et al.*, 1950). *Stachybotrys chartarum* synthesizes at least three enzymes capable of hydrolyzing β-glucosidase (Jermyn, 1955a), cellobiase (Youatt, 1958), and cellulase (Thomas, 1956). The specificity of these enzymes and their relationship was summarized by Youatt and Jermyn (1959). *Stachybotrys chartarum* produces the β-glucosidase over a wide range of culture conditions. The induction and biochemistry of this β-glucosidase has been intensively studied by Jermyn (1955a,b,c; 1962; 1965a,b,c; 1966a,b). Thomas (1956) reported that the optimum pH for the crude cellulase preparation from *S. chartarum* was 6.5-8.0.

Cochrane (1958) noted that pectin-polygalacturonase was found to occur in *S. chartarum*.

Of the 27 genera including 52 species of fungi, 6 species of Actinomycetes and 5 genera including 10 species of bacteria tested, Butt and Ghaffer (1972) found that *S. chartarum* (as *S. atra*) was able to inhibit the growth of 95.7% of the fungi, all the Actinomycetes and 83.3% of the bacteria.

MORPHOLOGY AND DEVELOPMENT

Members of *Stachybotrys* and *Memnoniella* are morphologically and developmentally closely related (Zuck, 1946; White *et al.*, 1949; Campbell, 1975). The unifying feature in common is the production of macronematous conidiophores with an apical cluster of several unicellular conidiogenous cells bearing unicellular enteroblastic-phialidic conidia (Barron, 1968; Kendrick & Charmichael, 1973). The genera differ primarily in the arrangement of the conidia, which are aggregated in slimy heads in *Stachybotrys* and in long persistent chains with the youngest conidium at the basal end of the chain in *Memnoniella* (Ellis, 1971a).

The conidiogenous cells of *Stachybotrys* and *Memnoniella* are considered to be phialides (Hughes, 1953; Tubaki, 1958; Barron, 1968; Ellis, 1971a; Kendrick & Carmichael, 1973). The phialide was defined by Kendrick (1971) as a conidiogenous cells in which at least the first conidium initial is produced within an apical extension of the cell and the conidium is literated by the rupture of the upper wall. Thereafter, from a fixed conidiogenous locus, the second and subsequent conidia are developed, each clad in an entirely new wall which is not derived from any existing layers of the wall of the conidiogenous cell. Any phialide wall distal to the conidiogenous locus is the collarette. The length of the phialide does not change while conidia are being produced.

However, the electron microscopical studies of phialoconidiogenesis in *Aspergillus clavatus* (Hanlin, 1976), *A. flavus* (Bojović-Cvetić & Vuyičić, 1974), *A. fumigatus* (Ghiorse & Edwards, 1973), *A. giganteus* (Trinci *et al.*, 1968), *A. nidulans* (Oliver, 1972), *A. niger*

(Tsukahara, 1970), *Neurospora crassa* (Lowrey *et al.*, 1967), *Metarrhizium anisopliae* (Hammill, 1972), *Verticillium albo-atrum* and *V. nigrescens* (Buckeley *et al.*, 1969), *Penicillium claviforme* (Zachariah & Fitz-James, 1967; Fletcher, 1971), *P. clavigerum* and *P. corymbiferum* (Fletcher, 1971), *Phialocephala dimorphospora* (Carroll & Carroll, 1974), *Phialophora richardsiae* (Olah & Reisinger, 1974) *Stilbothamnium nudipes* (Roguebert & Abadie, 1973), and *Trichoderma saturnisporum* (Hammill, 1974) have further refined the concept of phialoconidium formation. The characteristic features of phialoconidiogenesis are: (1) the inner cell wall of the conidiogenous cell gives rise to the conidium wall; (2) the successive production of conidia from a fixed conidiogenous locus inside the phialide shows no elongation once its tip is ruptured; (3) the phialoconidia are determined by transverse septa; and (4) the conidia are produced individually as discrete units to form slimy heads, or successive conidia are connected by a common septum to form persistent chains.

Campbell (1972; 1975) published the ultrastructure of conidiogenesis in *Stachybotrys chartarum* (as *S. atra*) and *Memnoniella echinata*. His interpretation and electron micrographs of both fungi appear essentially in agreement with those described for other enteroblastic-phialidic fungi mentioned above.

In *Stachybotrys* conidiophores arise from either intercalary or terminal cells of the mycelium. They are macronematous, morphologically different from purely vegetative hyphae, and determinate, i.e., the growth in length of the conidiophores ceases with the production of the first phialide. As the first phialide enlarges into its typical shape a cross septum is formed. Thereafter other phialides develop successively in a verticillate fashion below this septum, so that the first-formed phialide usually becomes the central one of the group. The wall of the phialide is continuous with the wall of the conidiophore. According to Campbell (1972) the septa which delimit the phialides from the conidiophore have a single central pore.

Phialides are always unicellular, generally cylindrical and usually slightly swollen in the upper portion before they taper to a narrow conidiogenous neck. The forming conidium first appears as a small bulbous enlargement at the tip of the phialide neck. Since the outer layers of the phialide wall break very soon after the first conidium starts expanding, the opening of the phialide neck becomes the collarette; this is very short, but distinctive even under the light microscope. The growth in length of a phialide ceases with the rupture of the phialide neck. All conidia appear to develop successively in a fixed conidiogenous locus just beneath the opening in a phialide. The wall of the conidia originates from the inner layer of the phialide tip. The succession of conidial formation causes the inward thickening of the inner wall layers of the collarette (Campbell, 1972).

Phialoconidia are always unicellular and acrogenous. The contents of the conidiogenous cell pass through the opening and the conidia take shape immediately on the outside of the collarette. They are enteroblastic in that the outer layers of the phialide wall are not involved in the formation of the conidial wall (Kendrick, 1971; Ellis, 1971). Just prior to dehiscence, a cross-wall is laid down at the base of the mature conidium and at this point the conidium is released from the phialide (Campbell, 1972). Conidia are produced singly and successively as separate units and produce a slime that forms a mucilaginous mass which envelops the tips of the phialides.

As mentioned earlier, *Memnoniella* and *Stachybotrys* differ morphologically in the arrangement of the conidia. Developmentally they are similar, except that the phialoconidia in *Memnoniella* are produced in a basipetal succession and are held to each other by a common septum in long persistent chains. According to Campbell (1975), the main difference between *Memnoniella* which produces chains of conidia and *Stachybotrys* which produces slimy heads is in the length of time between the formation of the septum in the phialide neck and its splitting when the conidia separate. In *Stachybotrys* the new conidia arise after previous ones are mature and have been released from the phialide neck, whereas in *Memnoniella* the new conidia arise in basipetal succession before the previous ones are mature. Essentially the same pattern of development of conidial chains seen in *Memnoniella* is also found in several other imperfect genera, e.g., *Aspergillus*, *Paecilomyces* and *Phialomyces* (Subramanian, 1972).

The shape, size, color, and ornamented surface of phialoconidia are used principally to distinguish the species of *Stachybotrys* and *Memnoniella*.

THE PERFECT STATE

Melanopsamma pomiformis (Pers. ex Fr.) Sacc. is the only ascomycetous fungus known to have a *Stachybotrys* conidial state. This relationship was established by earlier workers on the basis of the association of conidia and perithecial stromata in nature. According to Booth (1957), the first cultural verification was made in 1944 by E. W. Mason who found *Stachybotrys socia* Sacc. from single ascospore cultures of *M. pomiformis*. Booth further confirmed Mason's cultural evidence and discussed the taxonomic dispositions of this fungus, including perfect and imperfect states, in detail. The pertinent literature dealing with this relationship is summarized briefly and chronologically as follows:

1805 Albertini and Schweinitz first reported the possible conidial state of *Sphaeria pomiformis* Pers.

1871 Berkeley and Broome described *S. pomiformis* with the conidial state *Sporocybe albipes* Berk. & Br.

1875 Saccardo created a new name *Fuckelina socia* Sacc. for the conidial state of *Eriosphaeria raripila* Sacc. which was later identified by Saccardo (1877) with *Sphaeria pomiformis*.

1822 Saccardo combined *Melanopsamma pomiformis* with *Sporocybe albipes* as its conidial state and placed *F. socia* as a synonym.

1886 Saccardo described *F. socia* with a note that it was a conidial state of *M. pomiformis* and possibly identical with *S. albipes*.

1909 Ferraris transferred *Fuckelina socia* to *Stachybotrys* and proposed the new combination *Stachybotrys socia* (Sacc.) Sacc.

1912 Ferraris listed *Stachybotrys socia* as the conidial state of *Melanopsamma pomiformis*.

1923 Höhnel found *Gliobotrys alboviridis* Höhnel (1902) associated with perithecia of *M. pomiformis* and identified the former with *Sporocybe albipes* and *Fuckelina socia*. A new combination *Fuckelina albipes* (Berk. & Br.) Höhnel was made.

1957 Booth gave a detailed account of the conidial state of *M. pomiformis* with the description and illustration from single ascospore cultures. The disposition of the conidial state was discussed. He considered *Sporocybe albipes* (=*Fuckelina albipes*), *Fuckelina socia* (=*Stachybotrys socia*), and *Gliobotrys alboviridis* synonyms, but did not make a new combination.

1958 Hughes listed *Stachybotrys socia* as the conidial state of *M. pomiformis*.

1968 Verona and Mazzucchetti reproduced Booth's description and drawing of the conidial state of *M. pomiformis* under the name *Stachybotrys socia*.

No perfect states in the life history of any species of *Memnoniella* have been reported.

KEY TO THE SPECIES OF *STACHYBOTRYS* AND *MEMNONIELLA* IN CULTURE

(Based on cultures grown on cornmeal agar except *S. theobromae* which is on potato dextrose agar)

1. Phialoconidia in chains (*Memnoniella*). 2
1. Phialoconidia in mucilaginous masses (*Stachybotrys*) 3

2. Mature conidia mostly 3–6 μm in diameter . . . . . *M. echinata*
2. Mature conidia mostly 6–9 μm in diameter . . . . . *M. subsimplex*

3. Mature conidia colorless . . . . *S. bisbyi*
3. Mature conidia green or olive gray 4

4. Mature conidia green, more than 12 µm in width . . . . *S. theobromae*
4. Mature conidia olive gray, less than 9 µm in diameter 5

5. Surface of mature conidia smooth-walled . . . . *S. albipes*
5. Surface of mature conidia coarsely roughened or striated or banded and ridged 6

6. Mature conidia spherical . . . *S. microspora*
6. Mature conidia not spherical 7

7. Surface of mature conidia with striation . . . . *S. cylindrospora*
7. Surface of mature conidia coarsely roughened, without striation 8

8. Mature conidia 5-6 X 3-3.5 µm . *S. parvispora*
8. Mature conidia larger, more than 7 µm in length and 4 µm in width 9

9. Mature conidia reniform or ellipsoidal to reniform 10
9. Mature conidia ovate to ellipsoidal 11

10. Mature conidia reniform, 10-12 X 5-6 µm . . . . *S. nephrospora*
10. Mature conidia ellipsoidal to reniform, 9-10 X 5-7 µm . . *S. oenanthes*

11. Mature conidia showing banded or ridged roughenings . . . . *S. chartarum*
11. Mature conidia not as above 12

12. Mature conidia ovate, 7.5-10 X 5-7 µm . . . . *S. dichroa*
12. Mature conidia ellipsoidal, 10-14 X 6-7 µm . . . . *S. kampalensis*

DESCRIPTIONS AND ILLUSTRATIONS

Stachybotrys albipes (Berk. & Br.) Jong & Davis, comb. nov.

≡ *Sporocybe albipes* Berk. & Br., Ann. Mag. Nat. Hist. 8: 19. 1971.

≡ *Fuckelina albipes* (Berk. & Br.) Höhnel, Zbl. Bakt. Bd. 60, p. 13. 1923.

= *Fuckelina socia* Sacc., Nuovo G. Bot. Ital. 7: 326. 1875.

≡ *Stachybotrys socia* (Sacc.) Sacc. in Ferraris, Ann. Mycol. 7: 283. 1909.

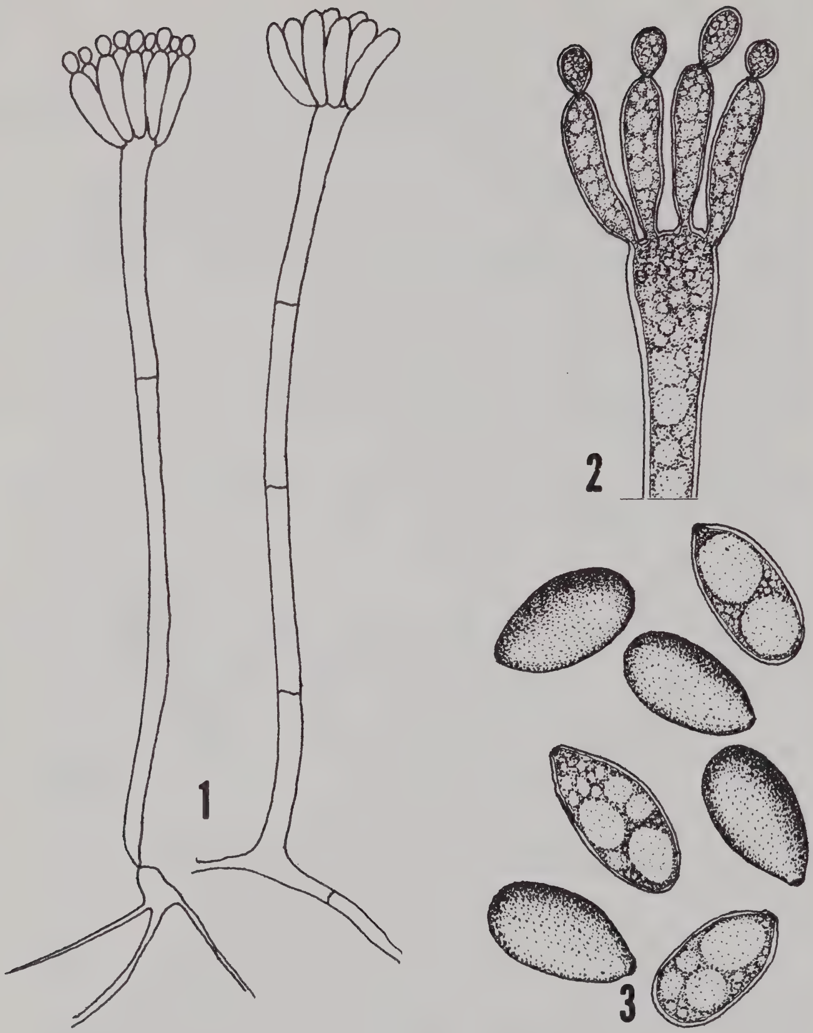
= *Gliobotrys alboviridis* Höhnel, S. B. Akad. Wiss. Wien, Abt. 1, 111: 1048. 1902.

Figures 1-6.

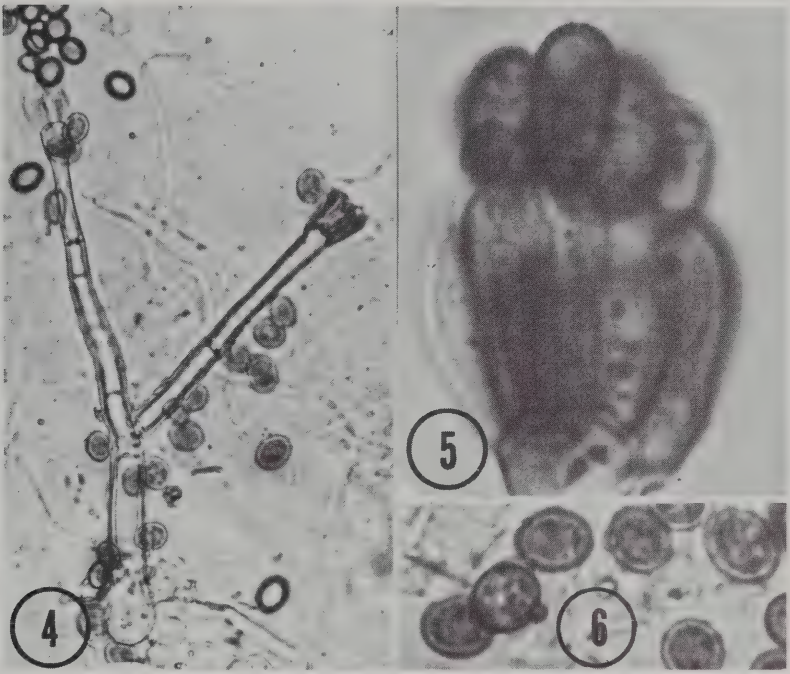
Growth on cornmeal agar extremely restrictied, attaining a diameter of 2 cm in 3 weeks. The surface of colony downy, uniformly dense, white, becoming dark granulate as conidia develop. Margin of colony distinct due to the absence of conidia, colorless, with compact submerged hyphae. No staining of medium in advance of mycelium. Reverse at first uncolored, later becoming olive green. Conidia produced abundantly a week following inoculation, first in the center, then centrifugally toward the margin of colonies.

Conidiophores determinate, macronematous, singly or in small groups, erect, straight or slightly curved, simple, occasionally branched, 3-7 μm wide, the basal cell slightly inflated and attenuate toward the tip, usually smooth throughout the length, but sometimes minutely rough-walled at the upper parts, slightly enlarged at the apex which bears terminal phialides in a whorl of 6-10 around a central phialide.

Phialides enteroblastic, determinate, discrete, unicellular, subclavate, hyaline, smooth-walled, 9-16 X 3-5 μm, with inconspicuous collarettes.



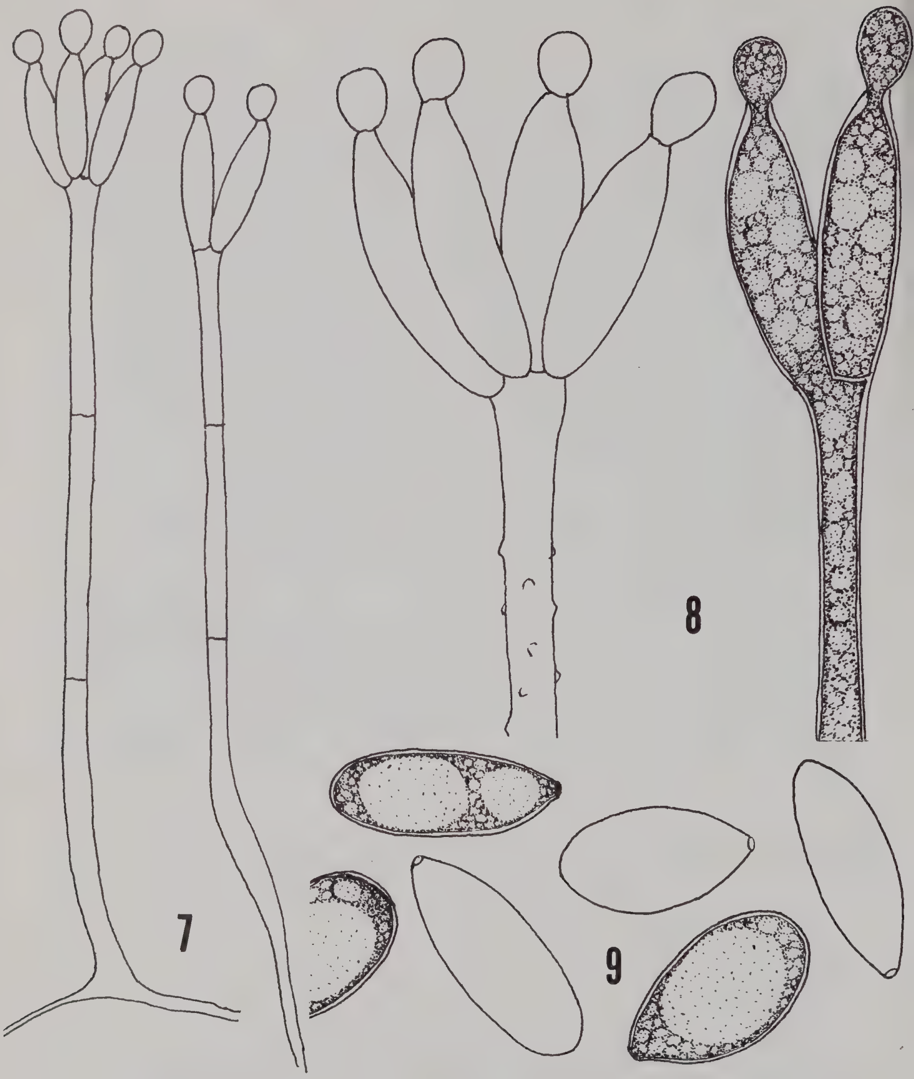
Figures 1–3. *Stachybotrys albipes* ATCC 18873.
1. Conidiophores with terminal phialides and phialoconidia. ca. X 500. 2. Phialides in a whorl of 4. ca. X 1,200.
3. Phialoconidia with a smooth surface. ca. X 2,400.



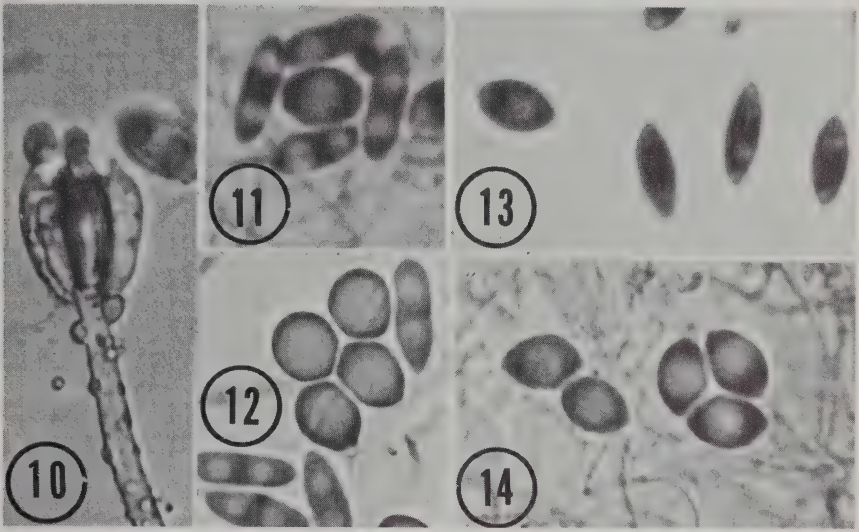
Figures 4-6. *Stachybotrys albipes* ATCC 18873.
4. Conidiophores with phialides and phialoconidia. ca. X 250. 5. Phialides with phialoconidia. ca. X 2,000. 6. Phialoconidia. ca. X 1,200.

Phialoconidia acrogenous, aggregated in slimy masses, unicellular, at first hyaline, when mature, dark olive gray, smooth-walled, ovate, size variable, 4-12 X 3-6 μm, mostly 7-9 X 5-6 μm.

REMARKS: The perfect state of this fungus is known to be *Melanopsamma pomiformis* (Pers. ex Fr.) Sacc. Booth (1957) has discussed the taxonomic dispositions of this fungus, including perfect and imperfect states, in detail. As the summary of the dispositions of the conidial state listed above, it appears that the name *Stachybotrys socia* is evidently preceded by *Sporocybe albipes* Berk. & Br. Since



Figures 7–9. *Stachybotrys bisbyi* ATCC 22173.
7. Conidiophores with phialides and phialoconidia.
ca. X 800. 8. Phialides. ca. X 2,000. 9. Phialoconidia.
Note the size and shape. ca. X 2,000.



Figures 10-14. *Stachybotrys bisbyi* from cotton blue in lactic acid mounts. 10. Phialides (ATCC 18825). ca. X 1,000. 11-14. Phialides. Note the size and shape. ca. X 1,000. 11. ATCC 18874. 12. ATCC 22215. 13-14. ATCC 22173.

Booth did not make a new combination, *Stachybotrys albipes* (Berk. & Br.) Jong & Davis is herein given in accordance with Articles 33 and 59 of the International Code of Botanical Nomenclature (Stafleu *et al.*, 1972).

The culture (ATCC 18873) studied is a single ascospore isolate of *M. pomiformis* which was originally isolated by Booth (1957) from *Ulmus* sp. in Fountains Abbey Woods, Yorkshire. This culture was received from Commonwealth Mycological Institute (CMI) as *Melanopsamma pomiformis* (Pers. ex Fr.) Sacc. IMI 56,393. It produces only a *Stachybotrys* state in culture. Growth and sporulation occur on cornmeal agar at temperatures in the range of 15 to 30 C. It grows on cellulose agar, but no clearing of the medium indicates that it is not a cellulose-decomposing strain. Morphologically, *Stachybotrys albipes* is akin to *S. dichroa* in having thick-walled simple conidiophores, but they can be distinguished by the ornamentation of the spore wall on which the former is smooth and the latter is coarsely roughened.

Stachybotrys bisbyi (Srinivasan) Barron, Mycologia 56: 315. 1964.

≡ *Hyalostachybotrys bisbyi* Srinivasan, J. Indian Bot. Soc. 37: 341. 1958.

= *Hyalostachybotrys sacchari* Srinivasan, J. Indian Bot. Soc. 37: 341. 1958.

≡ *Stachybotrys sacchari* (Srinivasan) Barron, Mycologia 56: 315. 1964.

= *Stachybotrys aurantia* Barron, Can. J. Bot. 40: 258. 1962.

Figures 7-14.

Colonies on cornmeal agar covering Petri dish plates in 2 weeks. The surface downy, uniformly dense, white, covered by a pale gray to salmon pink powdery bloom of conidial masses. Margin of colony not distinct, with compact hyphae. No staining of medium in advance of mycelium. Conidia produced abundantly a week after inoculation of plates. Cultures tending to lose the ability to produce conidia after several transfers.

Conidiophores determinate, macronematous, solitary or in groups, erect, straight or slightly curved, simple or branched, 2-5 septate, hyaline, up to 200 μm long, 3-4 μm wide, the basal cell slightly inflated, attenuate toward the tip, sometimes minutely rough-walled at the upper parts, sometimes more or less smooth throughout the length, slightly enlarged at the apex which bears terminal phialides in a whorl of 3-8 around a central phialide.

Phialides enteroblastic, determinate, discrete, unicellular, subclavate, hyaline, smooth-walled, 10-17 X 4-6 μm, with conspicuous collarettes.

Phialoconidia acrogenous, aggregated in slimy masses, hyaline, smooth-walled, one-celled, one to three guttulate, lemon-shaped or fusiform, 8-14 X 6-9 µm or 10-16 X 3-6 µm.

REMARKS: Bisby (1943) first reported a hyaline form of *Stachybotrys* isolated from soil by J. E. Machacek in Winnipeg, Canada. He called it a "pink *Stachybotrys*." When he knew Machacek later found a few more similar cultures from soil in Manitoba, Bisby (1945) suggested that it might represent a new genus and species.

Srinivasan (1958) concurred with Bisby's suggestion and created a new genus *Hyalostachybotrys* to accommodate these hyaline fungi resembling *Stachybotrys*. He described two species based on his own isolates from tropical South India. The type species, *H. bisbyi*, was isolated from rhizosphere of *Erianthus munja* Michaux and of *E. arundinaceus* Michaux. The "pink *Stachybotrys*" (IMI 10945) originally isolated from soil by Machacek was also disposed as *H. bisbyi*. The second species, *H. sacchari*, was a weak pathogen of sugar cane sheaths and was also isolated from the rhizosphere of sugarcane. The delimitation of these two species was primarily based on size and shape of phialospores. Srinivasan also clearly indicated that there were variations among the cultures studied by him in the amount of aerial mycelium, color of spore masses, branching of the conidiophores and in the size and shape of conidia.

Unaware of Srinivasan's work, Barron (1926) described a new soil hyphomycete, *Stachybotrys aurantia* Barron, which is identical with Srinivansan's *H. bisbyi*. Barron (1964) later disagreed with Srinivasan's creation of the genus *Hyalostachybotrys* because he believed that a genus based on color of the conidium would have no taxonomic validity. He therefore relegated *Hyalostachybotrys* to synonymy with *Stachybotrys*, and considered both of Srinivasan's species as *Stachybotrys*.

In the present study the following hyaline *Stachybotrys* isolates were studied.

ATCC 18825: received from L. W. Durrell, Colorado State Univ. (as *S. bisbyi*), isolated by W. A. Kreutzer from rhizosphere of Western wheat grass, Society Islands.

ATCC 18850 = IMI 100,544 (as *S. sacchari*): isolated by B. L. Mathur, from soil, India.

ATCC 18853 = IMI 116,426 (as *S. sacchari*): isolated by A. H. Moubasher from soil, Egypt.

ATCC 18874 = IMI 91,211 (as *S. sacchari*): isolated by J. R. Anderson from *Saccharum officinarum*, S. Africa.

ATCC 18885 = IMI 10,945 (as *S. bisbyi*): isolated by Machacek from soil, Canada.

ATCC 22172 = CBS 363.58 (as *S. bisbyi*): isolated by H. J. Swart from soil mangrove swamps, Mozambique.

ATCC 22173 = CBS 399.65 (as *S. bisbyi*): isolated by I. Focke from *Zea mays* root.

ATCC 22215: received from M. Morrall, Univ. of Saskatchewan (as *Stachybotrys* sp.), isolated from roots of grasses, Canada.

ATCC 22701: isolated by T. Matsushima from rotton wood, Papua-New Guinea (as *S. aurantia* MFC-2833).

ATCC 22702: isolated by T. Matsushima from soil, Papua-New Guinea (as *S. aurantia* MFC-4097).

Because of the extreme variability in the conidial morphology of these isolates, a clear differentiation of *S. bisbyi* and *S. sacchari* seems impossible. According to Srinivasan (1958), the size of conidia is 10.0-16.4 X 5.0-11.6 μm for *S. bisbyi* and 7.6-11.6 X 2.6-3.7 μm and 6.5-10.8 X 5.3-8.5 μm for *S. sacchari*. However, the description and illustration of *S. bisbyi* (as *S. aurantia*) given by Barron (1962) shows that it also properly fits the description and illustration of *S. sacchari* given by Srinivasan. It is apparent that in the past the concept of both species is overlapped and possibly one is the morphological variant of the other.

The species description presented is primarily based upon the strain ATCC 22173. Indeed, all the strains examined produce both globose and fusiform types of conidia, but most often they are dominated by one type depending on culture conditions such as media, temperature, light and age of cultures. The conidial size, 10-16 X 3-6 μm for fusiform and 8-14 X 609 μm for lemon-shaped, includes those of *S. bisbyi* and *S. sacchari* originally described by Srinivasan. Since *S. bisbyi* is the type species of the genus *Hylostachybotrys* and has a priority over *S. sacchari*, it is herein recommended that *S. sacchari* be considered a synonym of *S. bisbyi*.

Two additional hyaline species were described by Rifai (1964, 1974) from Java. *Stachybotrys bambusicola* Rifai was recovered on the fallen culm sheath of cultivated bamboo and *S. palmijunci* Rifai was on a decaying stem of the rattan *Daemonorhops melanochaetes* Bl. In both species the conidiophores are reddish brown and capable of elongating by proliferations; the phialoconidia are hyaline or subhyaline but pink in masses. They have only been recorded from the type locality and there are no cultures available for further studies. According to Rifai (1974), the two Javanese species are closely related but differ in size and shape of phialoconidia.

Stachybotrys chartarum (Ehrenb. ex Link) Hughes, Can. J. Bot. 36: 812. 1958.

≡ *Stilbospora chartarum* Ehrenb., Sylvae Myc. Berol. pp. 9, 21. 1818.

≡ *Oidium chartarum* Ehrenb. ex Link, Linn. Spec. Plant., IV, 6(1): 124. 1824.

≡ *Oospora chartarum* (Ehrenb. ex Link) Wallr., Flora Crypt. German. 2: 184. 1833.

= *Stachybotrys atra* Corda, Icon. Fung. 1: 21. 1837.

= *Aspergillus alternatus* Berk., Ann. Mag. Nat. Hist. 1: 262. 1838.

= *Sporocybe lobulata* Berk., Ann. Mag. Nat. Hist. 6: 434. 1841.

≡ *Stachybotrys lobulata* (Berk.) Berk., Outlines Brit. Fung. p. 343. 1860.

= *Synsporium biguttatum* Preuss, Klotzschii Herb. Viv. Mycol., No. 1285, anno 1849.

= *Stachybotrys alternans* Bon., Handb. Myk. 117. Fig. 185. 1851.

= *Memnonium sphaerospermum* Fuckel, Symb. Mycol. p. 358. 1870.

= *Stachybotrys scabra* Cooke & Harkness, Grevillea 12: 96. 1884.

= *Stachybotrys asperula* Massee & Cooke, Grevillea 16: 26. 1887.

= *Stachybotrys verrucosa* Cooke & Massee, Grevillea 16: 102. 1888.

= *Stachybotrys atrogrisea* Ellis & Ev., J. Mycol. 4: 106. 1888.

= *Trichosporum effusum* (Corda) Sacc. subsp. *binucleatum* Karst., Hedwigia 29: 272. 1890.

= *Stachybotrys gracilis* Em. March., Bull. Soc. Belg. Micro. 7: 265. 1894.

= *Stachybotrys pulchra* Speg., Rev. Agr. y Veter. La Plata. p. 248. 1896.

= *Stachybotrys elasticae* Koord., Botan. Untersuch. Java Pilza. p. 227. Fig. 37. 1907.

= *Stachybotrys dakotensis* Sacc., Atti Mem. R. Acad. Sci., Lett., Arti, Padova. 33: 174. 1917.

= *Stachybotrys voglinii* Cif., Ann. Mycol. 20: 48. 1922.

Figures 15-20.

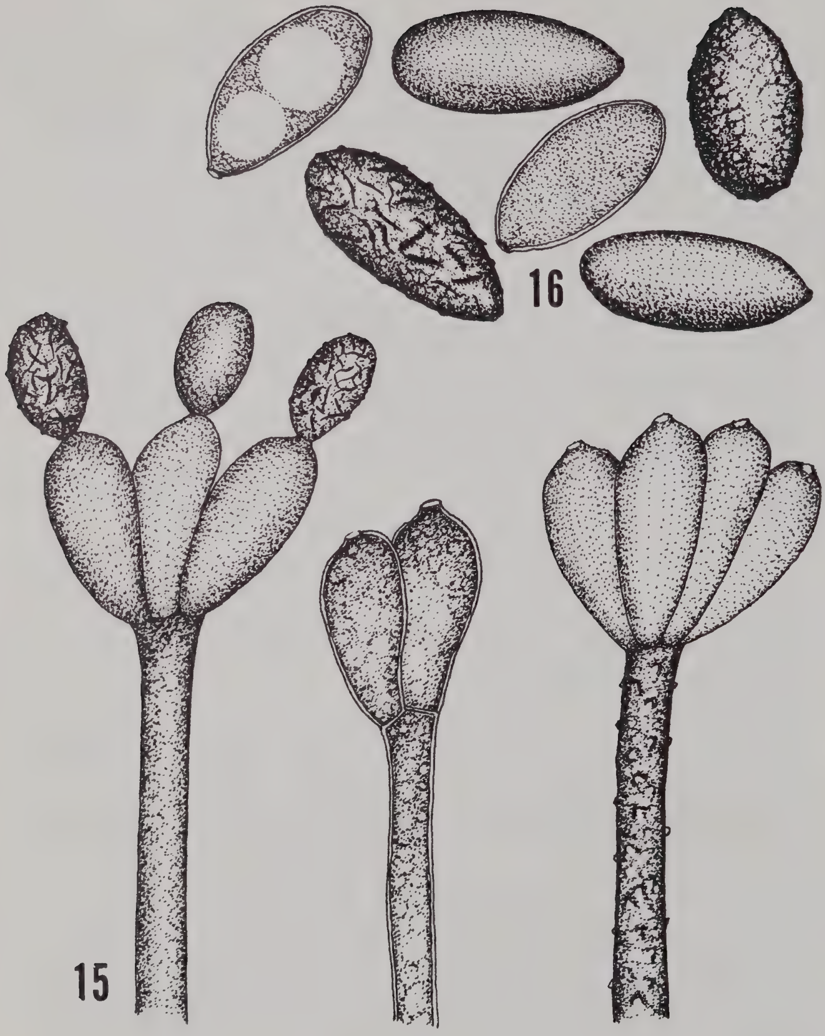
Colonies on cornmeal agar covering Petri-dish plates in 3 weeks, appressed, uniformly dense, uncolored at first, becoming dull dark, covered by a dark powdery bloom of conidial masses. Margin of colony distinct due to the absence of conidia, white, with compact hyphae. No staining of medium in advance of mycelium. Conidial production in abundance 3 days following inocluation on the plates.

Conidiophores determinate, macronematous, solitary or in groups, erect, straight or slightly curved, simple or irregularly branched, 2-4 septate, hyaline at the base, dark olivaceous toward the apex, length variable, up to 1,000 μm long, 3-6 μm wide, the basal cell slightly inflated, sometimes minutely rough-walled at the upper parts, sometimes more or less smooth throughout the length, slightly enlarged at the apex which bears terminal phialides in a whorl of 3-9 around a central phialide.

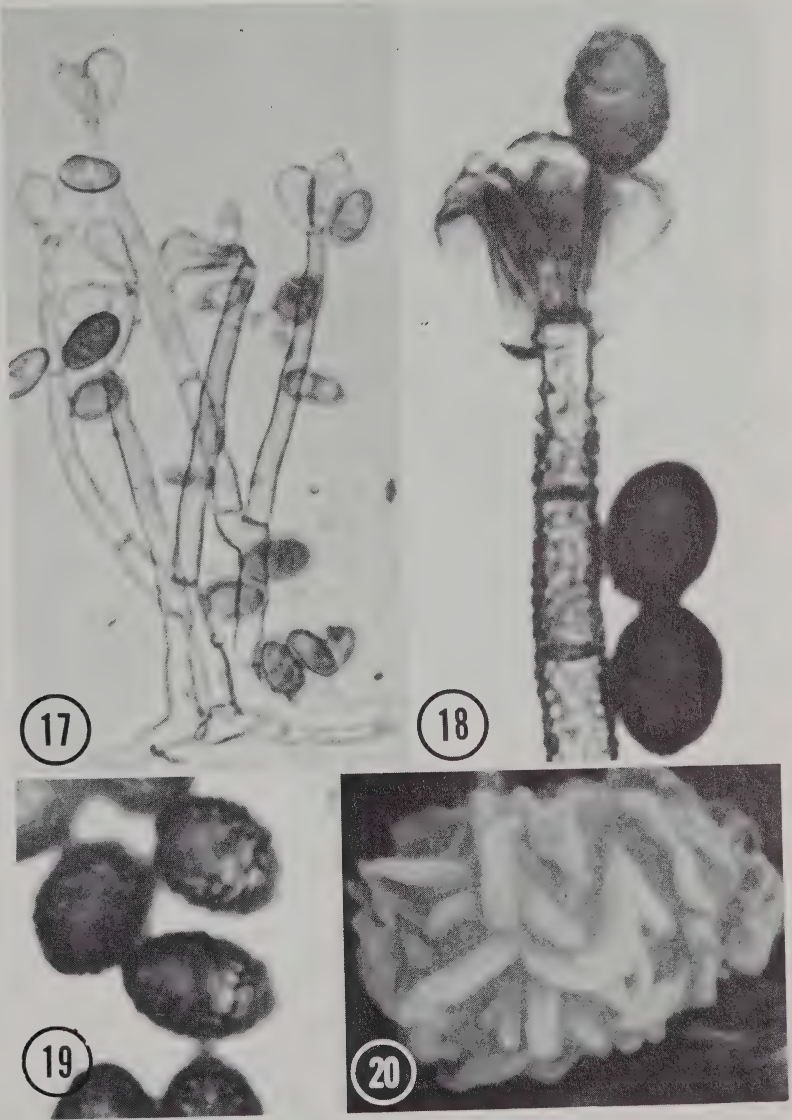
Phialides enteroblastic, determinate, discrete, unicellular, at first hyaline, later dark olivaceous, obovate or ellipsoid, smooth-walled, 9-14 X 4-6 μm, with conspicuous collarettes.

Phialoconidia acrogenous, arising singly and successively as separate units, aggregated in slimy masses, at first hyaline, when mature, dark olive gray, more or less opaque, smooth-walled or showing banded or ridged, ellipsoidal, unicellular, 7-12 X 4-6 μm.

REMARKS: *Stachybotrys atra*, the type species of the genus *Stachybotrys*, was first described by Corda (1837) with two-celled conidia. From critical studies of cultures and herbarium specimens, Bisby (1943) emended both generic and species descriptions with one-celled phialoconidia. Because of the great variability in the morphology of *S. atra* examined in culture, Bisby reduced more than ten *Stachybotrys* species which he thought were based on such morphological variants to synonyms with *S. atra*. Hughes (1958) later reexamined the type material of *S. atra* and identified it with *Stachybotrys chartarum* (Ehrenb.) Hughes. However, the correct combination should be *S. chartarum* (Ehrenb. ex Link) Hughes, in accordance with Article 13 of the International Code of Botanical Nomenclature (Stafleu *et al.*, 1972).



Figures 15-16. *Stachybotrys chartarum* ATCC 11716. 15. Phialides. Note the conspicuous terminal openings through which phialoconidia are being produced. ca. X 1,500. 16. Phialoconidia. Note the ridged or banded surface. ca. X 2,500.



Figures 17-20. *Stachybotrys chartarum* ATCC 11716. 17. Branching habit of conidiophores. ca. X 1,000. 18. Phialides. ca. X 2,000. 19-20. Phialoconidia featuring a ridged or banded surface. 19. Regular light micrograph. ca. X 2,000. 20. Scanning electron micrograph. ca. X 6,000.

The synonyms listed above are compiled from opinions of Bisby (1943) and Hughes (1958).

The following cultures were studied and are considered to be *S. chartarum*.

ATCC 9182 = NRRL 1877 = QM 1274 (as *S. atra*): isolated by W. Crozier from paper, Washington, D. C.; used in United States for testing mildew proofing.

ATCC 11695 = QM 94d (as *S. atra*): isolated by E. T. Reese from Trousers, New Guinea; used in cellulose and wool decomposition.

ATCC 11716 = IFO 5369 (as *S. lobulata*): isolated by Y. Sasaki (F-14) from coal, Japan.

ATCC 16026 = IMI 82,021 (as *S. atra*) = QM 8401: isolated by R. M. Everett from cotton fabric, U. K.; meets British specifications for fungus resistance tests.

ATCC 18541: isolated by Carol A. Shearer from balsa wood submerged in Patuxent River, Maryland.

ATCC 18836 = IFO 7222: isolated by K. Tubaki (TC-63-1), Japan.

ATCC 18842 = CBS 222.46 (as *S. atra*): isolated by M. B. Bok from flax fibre.

ATCC 18843 = CBS 324.65 (as *S. atra*): isolated by CBS staff from tile.

ATCC 18844 = CBS 328.37 (as *S. atra* var. *brevicaulis*): isolated by O. Verona from paper.

ATCC 18845 = CBS 329.37 (as *S. atra* var. *genuina*): isolated by O. Verona from paper.

ATCC 18846 = CBS 330.37 (as *S. atra* var. *lobulata*): isolated by O. Verona from paper.

ATCC 18847 = CBS 341.35 (as *S. atra*): isolated by N. F. Conant.

ATCC 18875 = IMI 42,310 (as *S. atra*): isolated in Peshawa, India.

ATCC 18979: isolated by O. Fassatiova (as *S. alternans* CCF 584).

ATCC 22127: isolated by D. Mallock from woodchuck dung.

ATCC 22218 = IMI 136,344 (as *S. atra* var. *microspora*): isolated by C. V. Subramanian from soil, India.

ATCC 22703: isolated by T. Matsushima (MFC-2762) from soil, Goroka.

ATCC 26303 = QM 1533 (as *S. atra*): isolated by W. L. White from old cardboard dumped in wasteland; produces 12,13-epoxy-Δ^9-trichothecenes as the mycotoxins responsible for stachybotryotoxicosis (Eppley & Bailey, 1973).

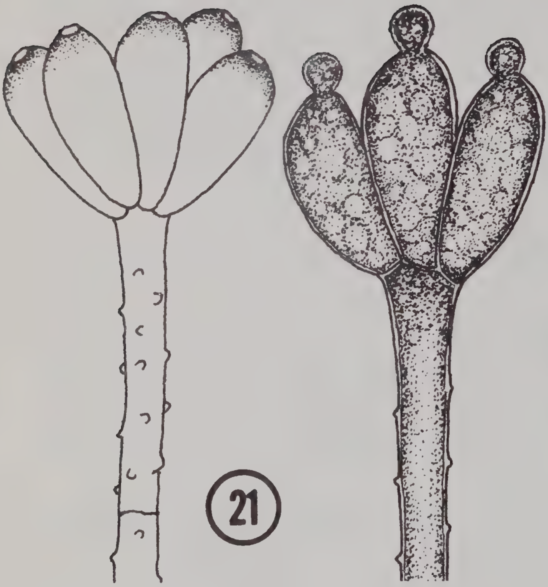
ATCC 26384: isolated by A. Ylimaki from barley, Finland; agent of stachybotryotoxicosis of laboratory animals (Korpinen, 1973).

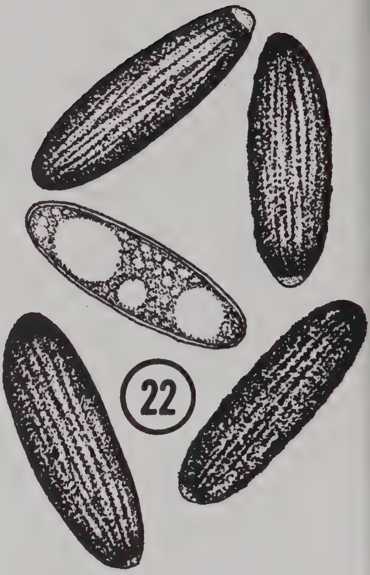
ATCC 26385: isolated by A. Ylimaki from wheat, Finland; agent of stachybotryotoxicosis of laboratory animals (Korpinen, 1973).

ATCC 26386: isolated by A. Ylimaki from commercial pig feed, Finland; agent of stachybotryotoxicosis of laboratory animals (Korpinen, 1973).

The distinguishing feature of this species is the mature phialoconidia showing a ridged or banded surface and their size.

All the strains studied grow and sporulate well on CMA and rabbit food agar at temperatures in the range of 10 to 37 C. The upper limit of temperature for spore germination is also 37 C. Production of clearing by growth on cellulose agar medium indicates that it is a strong cellulose-decomposing fungus. ATCC 9182 and ATCC 16026 are being used for fungus resistance tests in U. S. and British military specifications.





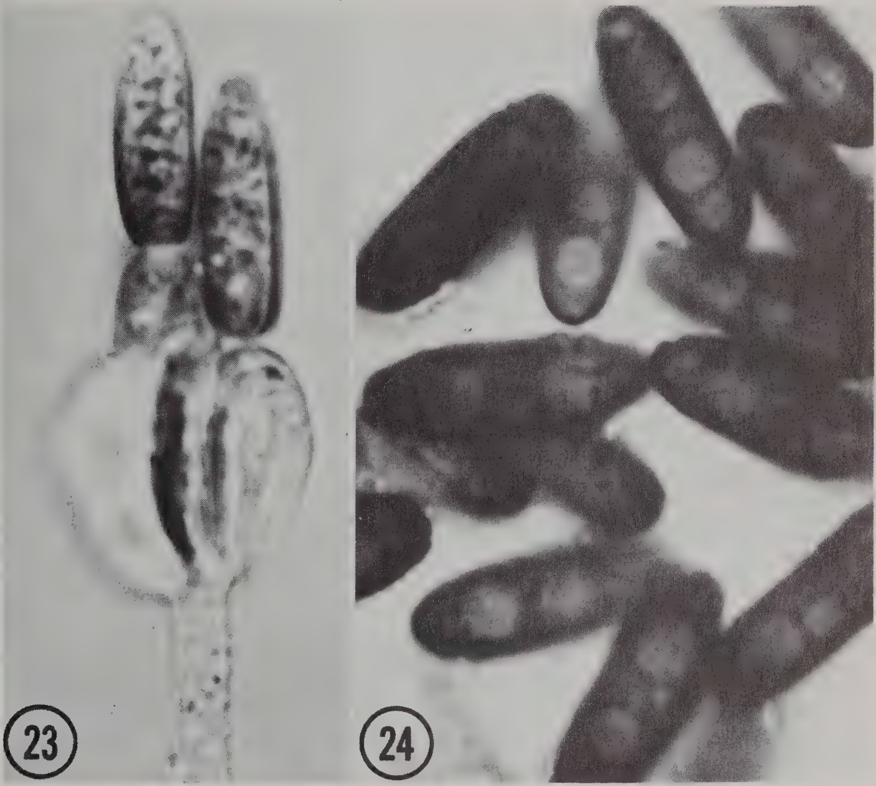
Figures 21-22. *Stachybotrys cylindrospora* ATCC 18851. 21. Phialides. ca. X 2,000. 22. Phialoconidia. Note striations running along the length of conidia. ca. X 2,000

Stachybotrys cylindrospora Jensen, Cornell Univ. Agr. Exp. Sta. Bull. 315: 496. 1912.

≡ *Stachybotrys atra* Corda var. *cylindrospora* (Jensen) Rayss & Borut, Mycopath. Mycol. Appl. 10: 168. 1956.

Figures 21-24.

Colonies on cornmeal agar covering Petri-dish plates in 3 weeks, downy to felty, colorless at first, becoming dark, with a granulate surface as conidial production commences. Margin of colony not distinct, with compact hyphae and very few conidia. Reverse stained yellowish pink. Conidia produced in abundance a week after inoculation of plates.



Figures 23-24. *Stachybotrys cylindrospora* ATCC 18851. 23. Phialides. ca. X 2,000. 24. Phialoconidia showing delicate striations. ca. X 2,000.

Conidiophores determinate, macronematous, solitary or in groups, erect, straight or slightly curved, simple or irregularly branched, 3-5 septate, hyaline at the base, slightly olivaceous toward the apex, length variable, up to 200 µm long, 3-5 µm wide, the basal cell slightly inflated, attenuate toward the tip, sometimes minutely rough-walled at the upper parts, sometimes more or less smooth throughout the length, slightly enlarged at the apex which bears terminal phialides in a whorl of 3-9 around a central phialide.

Phialides enteroblastic, determinate, discrete, unicellular, subclavate, dark olivaceous at the tip, smooth-walled, 11-16 X 4-5 µm, with conspicuous collarettes.

Phialoconidia acrogenous, arising singly and successively as separate units, aggregated in slimy masses, at first hyaline and smooth-walled, when mature, dark olive gray, surface showing delicate striations running obliquely along the length of the conidia, cylindrical, long and narrow, 2 to 4 times as long as broad, unicellular, 13-16 X 4-6 μm, usually containing two oil drops.

REMARKS: *Stachybotrys cylindrospora* was first discovered by Jensen in 1912 from soil in New York state. Since the original description of this species showed so much resemblance to that of *S. chartarum* (as *S. atra*), Bisby (1943) suggested that they were possibly synonymous. Rayss and Borut (1956) later recognized the fungus as a variety of *S. chartarum* (as *S. atra*) mainly by the phialoconidia which are cylindrical and thinner than in the typical variety. In studies of the flora of organic soil in Ontario, Canada, Barron (1961) obtained several isolates which agree well with Jensen's description and suggested that *S. cylindrospora* should be recognized as a distinct species.

The culture ATCC 16276 was isolated by W. Gams from wheat field soil in Kitzeberg, Germany, and determined by G. L. Hennebert as *S. cylindrospora*. ATCC 18851 (= IMI 85,334) was isolated and identified by G. L. Barron (1961) from peat soil in Quelph, Canada. Both strains studied appear to be quite distinctive from the type species *S. chartarum* in having phialoconidia, as the specific epithet indicates, long and narrow, and the surface featuring delicate striations running obliquely along the length of the conidia. The fungus is now known in Europe, Japan, North America, British Solomon Islands (Matsushima, 1971a; 1975), and is well established in different climate regions of the world. Thus, it has been shown that this species is a clearly defined fungus taxon.

The temperature range for growth and conidial germination of the fungus is from 15 to 30 C. No production of clearing by growth on the cellulose agar medium indicates that it is not a cellulose-decomposing fungus.

Stachybotrys dichroa Grove, J. Bot. Lond. 24: 201. 1886.

Figures 25-30.

Growth on cornmeal agar extremely restricted, attaining a diameter of 2 cm in 3 weeks. The surface of colony downy, orange, with little or no aerial mycelium. Margin of colony not distinct, with compact hyphae. Reverse stained bright orange. Conidial production usually sparse, confined to the central part of the colony. Cultures tending to lose their ability to produce conidia after several transfers.

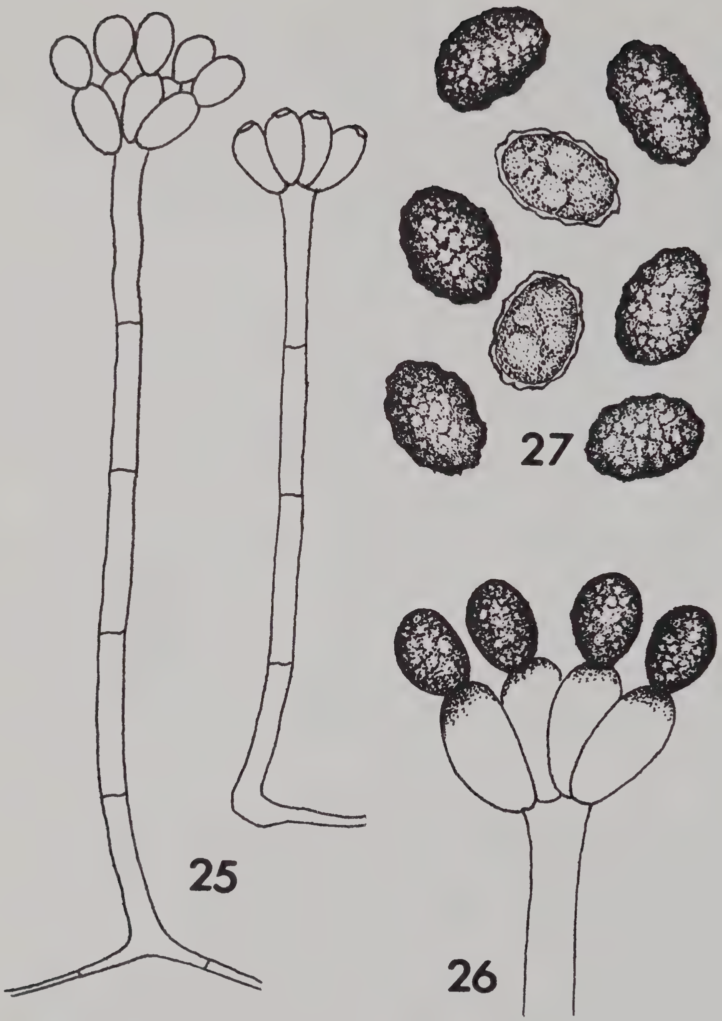
Conidiophores determinate, macronematous, solitary or in groups, erect, straight or slightly curved, simple, 2-7 septate, hyaline, thick-walled, lenght variable, up to 210 μm long, 4-9 μm wide, the basal cell slightly inflated, attenuated toward the tip, usually smooth throughout the length, slightly enlarged at the apex which bears terminal phialides in a whorl of 4-6 around a central phialide.

Phialides enteroblastic, determinate, discrete, unicellular, subclavate, hyaline, smooth-walled, 8-10 X 5-6 μm, with conspicuous collarettes.

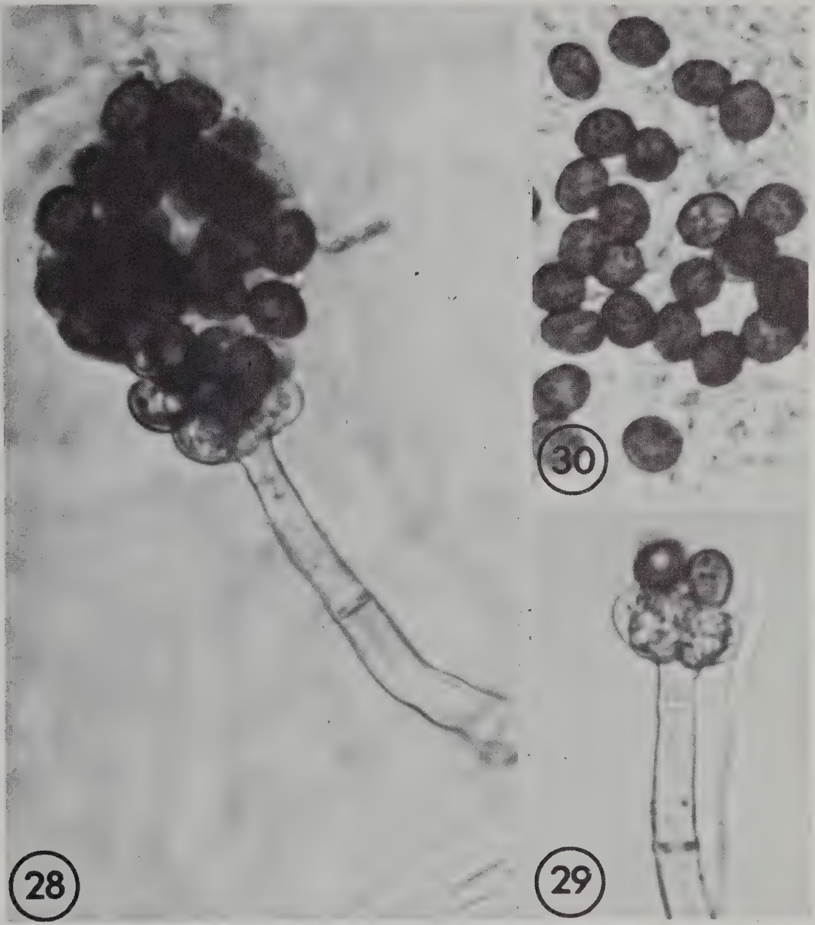
Phialoconidia acrogenous, arising singly and successively as separate units, aggregated in slimy masses, at first hyaline, when mature, dark olive gray, more or less opaque, coarsely roughened, unicellular, ovate, 7.5-10 X 5-7 μm.

REMARKS: On examination of Grove's type material, Bisby (1943) first concluded that *S. dichroa* was young *S. chartarum* (as *S. atra*). However, Bisby and Ellis (1949) later recognized *S. dichroa* as a taxonomically distinct species after studying six collections from different localities, including two in culture. The fungus is easily distinguished by its habitat, cultural characteristics and the thick-walled simple conidiophores. According to Bisby and Ellis (1949), it is not uncommon on dead stems of herbaceous plants in England. It has not been found from soil.

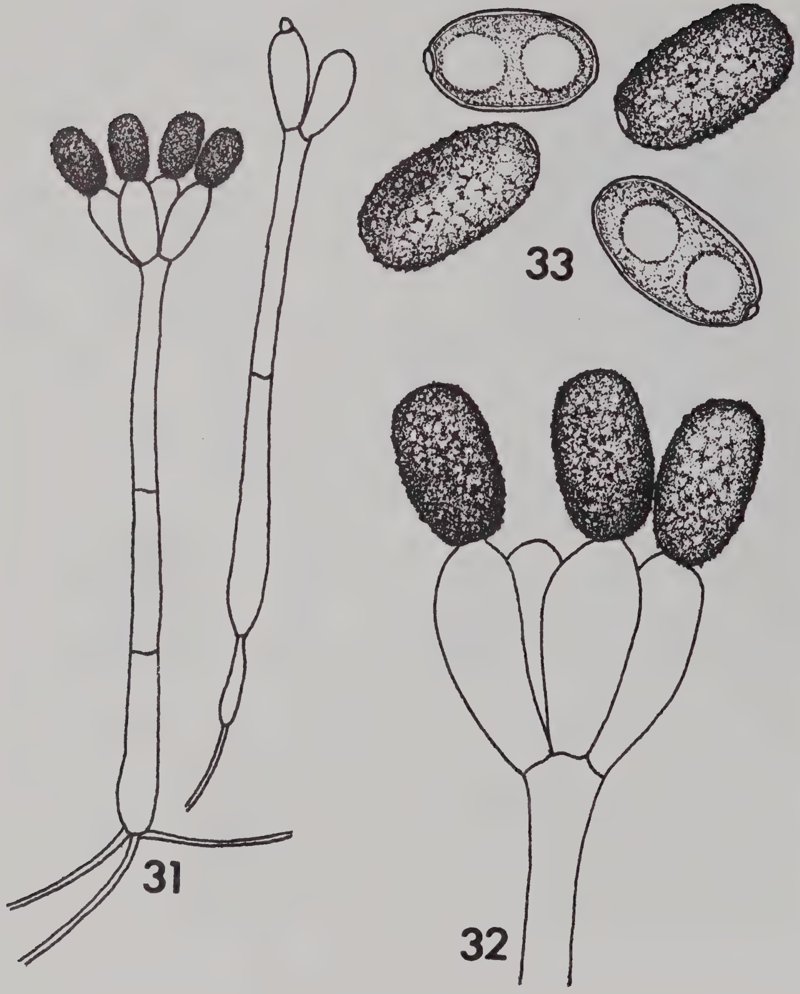
The culture ATCC 18913 (=IMI 17,506) studied was isolated by M. B. Ellis from a dead herbaceous stem and further studied by Bisby and Ellis (1949). It grows and sporulates on cornmeal agar at temperatures in the range of 15 to 26 C. The upper limit of temperature for spore germination is 30 C. Production of clearing by growth on cellulose agar medium indicates that it is a cellulose-decomposing fungus.



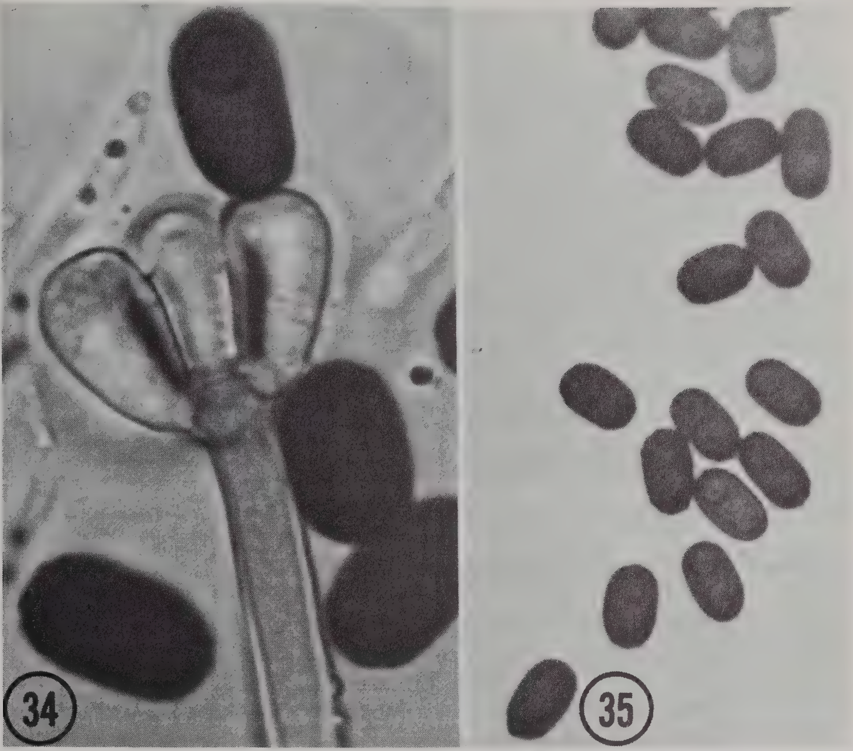
Figures 25-27. *Stachybotrys dichroa* ATCC 18913.
25. Conidiophores with phialides and phialoconidia. ca. X 500. 26. Phialides. ca. X 1,500. 27. Phialoconidia. ca. X 1,800.



Figures 28-30. *Stachybotrys dichroa* ATCC 18913. 28. Conidiophore with terminal phialides bearing a slimy mass of conidia. ca. X 1,000. 29. Phialides with phialoconidia. ca. X 1,000. 30. Mature phialoconidia featuring a coarsely roughened surface. ca. X 1,000.



Figures 31-33. *Stachybotrys kampalensis* ATCC 22705. 31. Conidiophores with phialides and phialoconidia. ca. X 800. 32. Phialides and phialoconidia. ca. X 2,000. 33. Phialoconidia. ca. X 2,000.



Figures 34-35. *Stachybotrys kampalensis* ATCC 22705.
34. Phialides and phialoconidia. ca. X 2,000.
35. Phialoconidia. ca. X 1,000.

Stachybotrys kampalensis Hansford, Proc. Linn. Soc. Lond. 155: 45. 1943.

Figures 31-35.

Growth on cornmeal agar somewhat restricted, reaching 3 cm in diameter in 2 weeks, appressed, uniformly dense, uncolored at first, becoming dull dark, covered by a dark bloom of conidial masses. Margin of colony distinct due to the absence of conidia, with compact hyphae. No staining of medium in advance of mycelium. Conidial production abundant 3 days following inoculation on the plates.

Conidiophores determinate, macronematous, usually solitary but occasionally in groups, straight or slightly curved, simple, 1-3 septate, hyaline, thick-walled, length variable, up to 180 μm long, 4-8 μm wide, smooth throughout the length, the basal cell inflated, tapering toward the apex which bears terminal phialides in a whorl of 4-8 around a central phialide.

Phialides enteroblastic, determinate, discrete, unicellular, hyaline, obovate to ellipsoid, smooth-walled, 9-13 X 6-7 μm, with conspicuous collarettes.

Phialoconidia acrogenous, arising singly and successively as separate units, aggregated in slimy masses, at first hyaline and smooth-walled, when mature, dark olivaceous to almost black, heavily verrucose, ellipsoidal, unicellular, 10-14 X 6-7 μm, usually containing two oil drops.

REMARKS: *Stachybotrys kampalensis* was first discovered by Hansford (1943) on dead wood in Uganda. Hughes (1952) later reported three additional collections from the Gold Coast on petioles of *Carica papaya* L. and stems of *Hibiscus esculentus* L. Matsushima (1975) also found this fungus in Japan on leaves of *Pueraiae hirsutae* and *Musae paradisiacae*.

The strain ATCC 22705 studied was isolated by Matsushima (1971) from forest soil in New Guinea. The strain ATCC 32255, a subculture of CBS 388.73, was isolated from *Euphorbia tirukalli*. The identity of both strains has been further confirmed by a comparative study with the Hansford's type material deposited at the Kew Herbarium (K), England. They grow and sporulate on cornmeal agar at temperatures in the range of 15 to 30 C. No production of clearing on the cellulose agar medium indicates that the fungus does not decompose cellulose.

Stachybotrys microspora (Mathur & Sankhla) Jong & Davis, comb. nov.

≡ *Stachybotrys atra* Corda var. *microspora* Mathur & Sankhla, Sci. Culture 32: 93. 1966.

Figures 36-40.

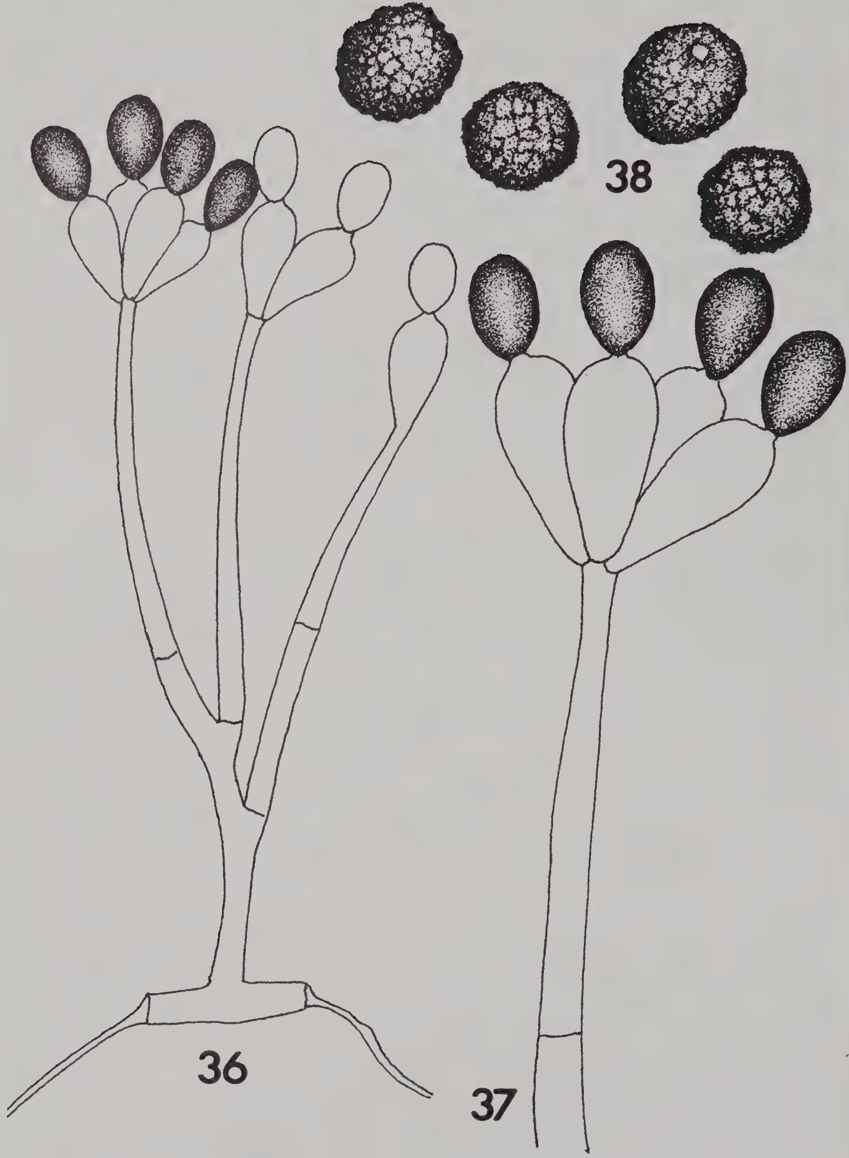
Colonies on cornmeal agar covering Petri-dish plates in 3 weeks, appressed, uniformly dense. Central parts of colonies becoming dull dark, covered by a dark powdery bloom of conidial masses. Margin of colonies not distinct, with compact hyphae. No staining of medium in advance of mycelium. Conidial production abundant, confined to the central part of the colony.

Conidiophores determinate, macronematous, solitary or in groups, irregularly dark olivaceous toward the apex, up to 55 μm long, 2-4 μm wide, usually smooth throughout the length, sometimes minutely rough-walled at the upper parts, the basal cell inflated, tapering toward the apex which bears terminal phialides in a whorl of 2-6 around a central phialide.

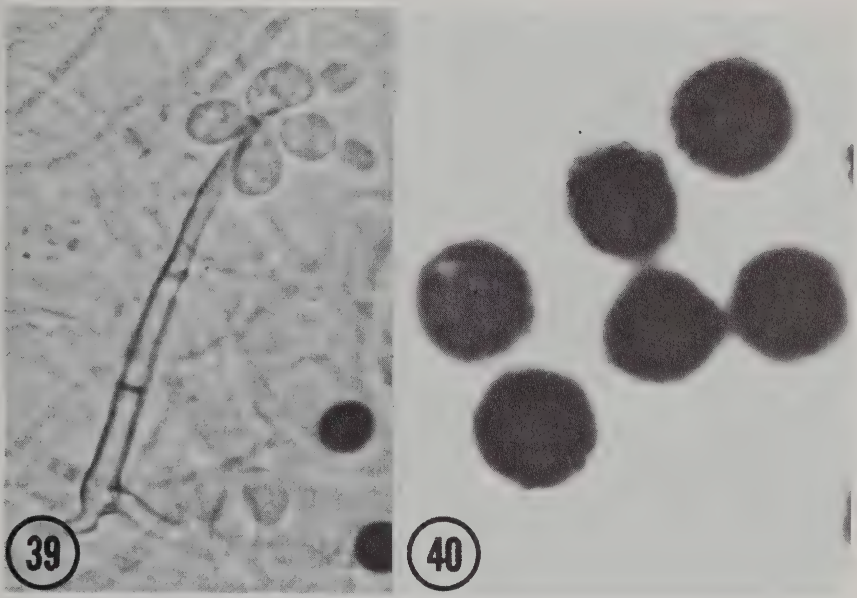
Phialides enteroblastic, determinate, discrete, clustered in a verticillate arrangement, unicellular, slightly dark olivaceous, obovate to pyriform, smooth-walled, 8-9 X 4-5 μm, with conspicuous collarettes, detachable from conidiophores.

Phialoconidia acrogenous, arising singly and successively as separate units, aggregated in slimy masses, when young appearing as more or less elliptical or pyriform 6-8 X 4-5 μm, becoming globose, 5-6 μm in diameter at maturity, dark olive gray, more or less opaque, coarsely roughened, unicellular.

REMARKS: Mathur and Sankhla (1966) first discovered this fungus from soil in Jaipur, India, and described it as *Stachybotrys atra* Corda var. *microspora* Mathur & Sankhla. The dried type culture of this fungus was deposited in the herbarium of the Commonwealth Mycological Institute (IMI 91,933). An examination of this plate culture shows that it is mixed with *Stachybotrys chartarum*. Fortunately, each can be identified in accordance with its colony characteristics. A permanent slide made from a colony of *S. atra* var. *microspora* of this type material has been deposited in the herbarium of the National Fungus Collections (BPI), Beltsville, Maryland. The strain ATCC 18852 (=IMI 124,902) was isolated by D. McDonald from *Arachis hypogaea* rhizosphere in Zaria, N. Nigeria, in 1967. It is in full agreement with the type material. Since the culture characteristics, conidia and conidiophores are easily distinguished from those of *S. chartarum*, we would



Figures 36-38. *Stachybotrys microspora* ATCC 18852. 36. Branching habit of a conidiophore with phialides and phialoconidia. ca. X 1,500. 37. Phialides. ca. X 2,000. 38. Mature phialoconidia. ca. X 2,000.

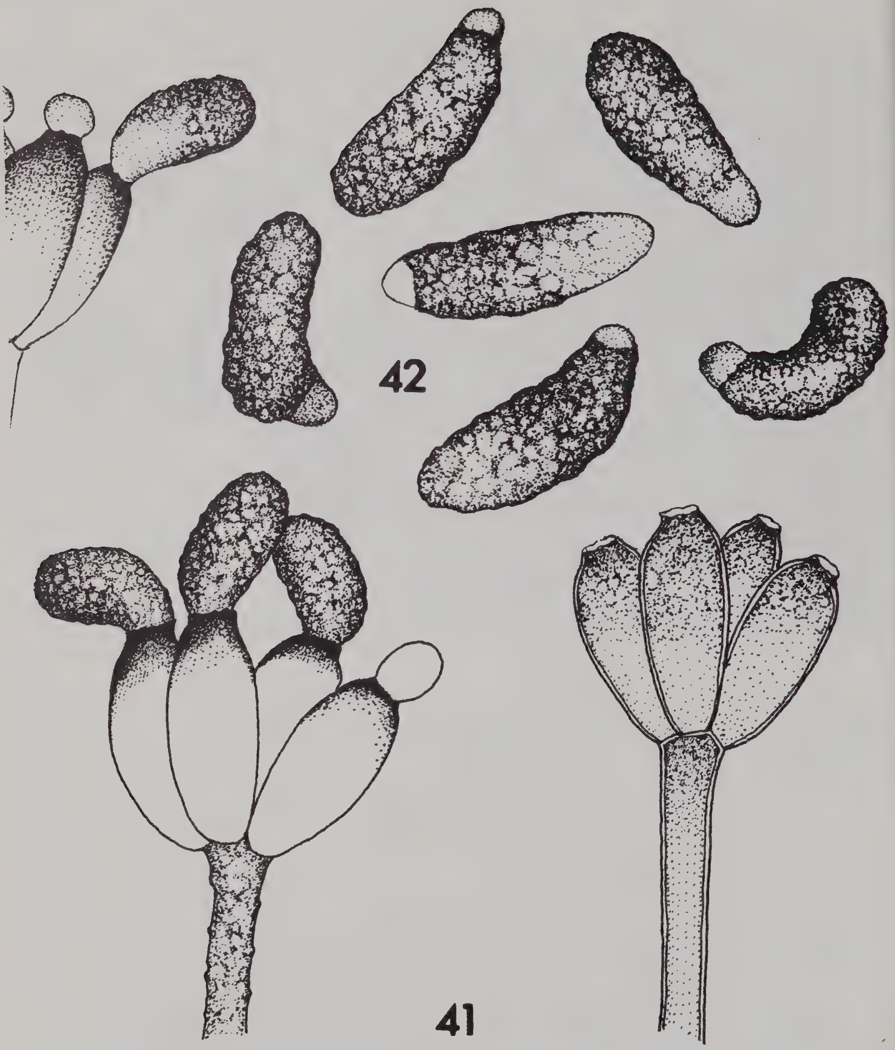


Figures 39-40. *Stachybotrys microspora* ATCC 18852. 39. Growth habit of a conidiophore. ca. X 1,000. 40. 40. Mature phialoconidia featuring a coarsely roughened surface. ca. X 2,000.

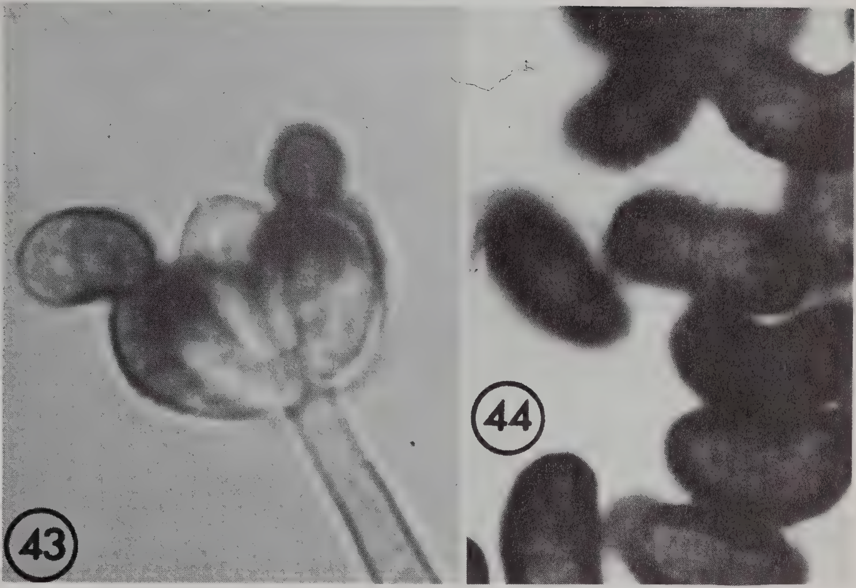
recognize it as a species and make a new combination *Stachybotrys microspora* (Mathur & Sankhla) Jong & Davis.

The strain ATCC 22218 originally designated as *S. atra* var. *microspora* at the Commonwealth Mycological Institute as IMI 136,344 appears to be a typical *S. chartarum* and is now disposed under the latter name at the ATCC.

The temperature range for growth and conidial germination of ATCC 18852 is from 15 to 37 C. No clearing on cellulose agar medium by growth reveals that the fungus is unable to utilize the cellulose as a main carbon source.



Figures 41-42. *Stachybotrys nephrospora* ATCC 18839. 41. Phialides. ca. X 3,000. 42. Phialoconidia. ca. X 3,000.



Figures 43-44. *Stachybotrys nephrospora* ATCC 18839. 43. Phialides showing wide terminal openings through which phialoconidia are being produced. ca. X 3,000. 44. Comma-shaped phialoconidia featuring a coarsely roughened surface. ca. X 3,000.

Stachybotrys nephrospora Hansford, Proc. Linn. Soc. London 155: 45. 1943.

= *Stachybotrys reniformis* Tubaki, Trans. Mycol. Soc. Japan 4: 86. 1963.

= *Stachybotrys sinuatophora* Matsushima, Bull. Nat. Sci. Mus. Tokyo 14: 476. 1971.

Figures 41-44.

Growth on CMA somewhat restricted, attaining a diameter of 4-5 cm in 3 weeks, appressed, uniformly dense, uncolored at first, becoming dark granulate as conidial production commences. Margin of colony distinct due to the absence of conidia, white, with compact hyphae. No staining of medium in advance of mycelium. Reverse olive green. Conidial production abundant a week following inoculation, first in the center, then centrifugally toward the margin of colonies, becoming zonate.

Conidiophores determinate, macronematous, solitary or in groups, erect, straight or slightly curved, simple, occasionally branched, 2-4 septate, at first hyaline, becoming olivaceous at the upper parts, up to 400 μm long, 3-5 μm wide, sometimes minutely rough-walled at the upper parts or throughout the length, sometimes more or less smooth throughout, slightly enlarged at the apex which bears terminal phialides in a whorl of 4-9 around a central phialide.

Phialides enteroblastic, determinate, discrete, unicellular, olivaceous, obovate or ellipsoid, smooth-walled, 10-12 X 5-6 μm, with conspicuous collarettes.

Phialoconidia acrogenous, arising singly and successively as separate units from an open growing point at the apex of the phialide, bent away outwardly from the axis even horizontally sliming down at once to form a mucilaginous black mass which envelopes the tips of the phialides, at first hyaline and smooth-walled, when mature, dark olive, more or less opaque, coarsely roughened, unicellular, reniform or comma-shaped, 10-12 X 4-5 μm.

REMARKS: *Stachybotrys nephrospora* was first discovered by Hansford (1943) on dead wood in Kamplala, Uganda. The type specimen (Hansford 1114) was deposited in the Kew Herbarium (K), Royal Botanic Garden, England. It is readily recognized by the reniform phialoconidia which develop obliquely or even horizontally from the wide open apex of the phialide. Tubaki (1963) described a new species, *Stachybotrys reniformis*, from the decayed leaves of an herb (Labiatae) in Ambo, Yaki Island, Japan. Since the shape and size of phialoconidia agree fairly well with those of *S. nephrospora*, Verona and Mazzucchetti (1968) suggested that *S. reniformis* and *S. nephrospora* were possibly synonymous.

Matsushima (1971a,b) recently isolated a similar fungus from Goroka soil, Papua-New Guinea; however, he described it as a new species, *Stachybotrys sinuatophora*

Matsushima. This isolate (MFC-2690) was deposited in the ATCC and given accession number ATCC 22706.

The description presented is based upon the type culture (ATCC 18839 = IFO 7067) of *S. reniformis* which was obtained from Institute for Fermentation (IFO) in Osaka, Japan. No culture is available for *S. nephrospora* which is known from the type collection only. Comparative studies of the type specimen of *S. nephrospora* and the type cultures of both *S. reniformis* and *S. sinuatophora* have led to the conclusion that they are identical. It is therefore proposed that *S. reniformis* Tubaki, 1963, and *S. sinuatophora* Matsushima, 1971, be regarded as later, facultative synonyms of *S. nephrospora* Hansford, 1943.

Both ATCC 18839 and ATCC 22706 grow and sporulate well on cornmeal agar at temperatures ranging from 15 to 30 C. However, ATCC 18839 is capable of producing cellulase on the cellulose agar medium and ATCC 22706 is unable to do so.

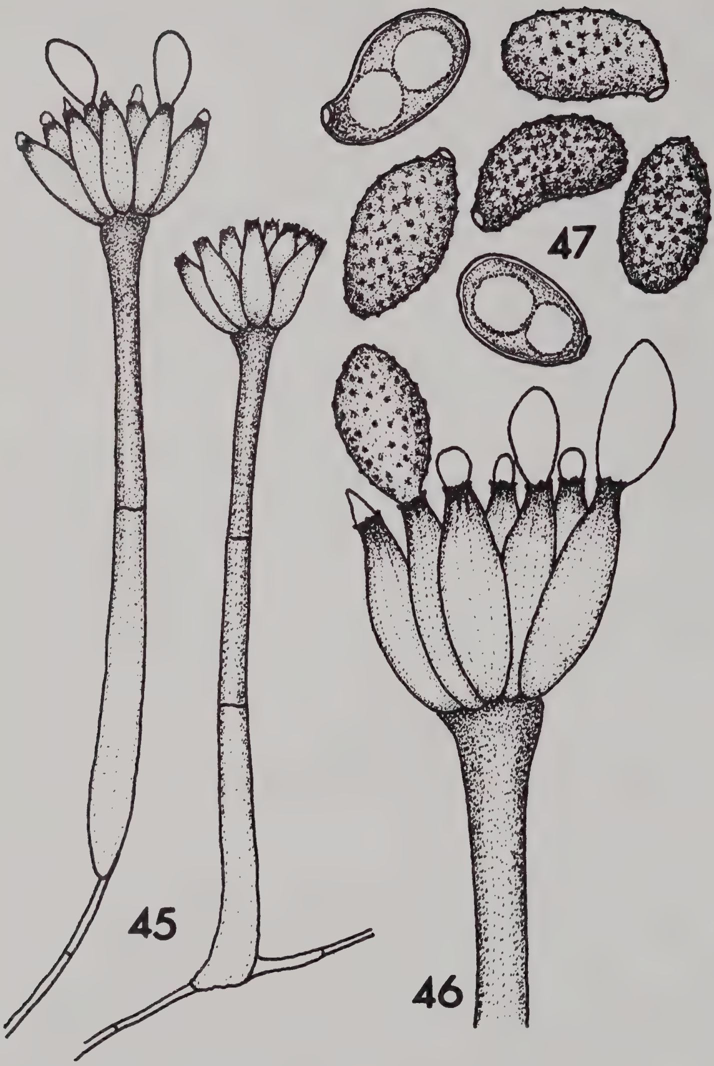
Stachybotrys nephrospora is characterized by its synpodially branched conidiophores and its reniform phialoconidia.

Stachybotrys oenanthes M. B. Ellis, CMI Mycol. Papers 125: 29. 1971.

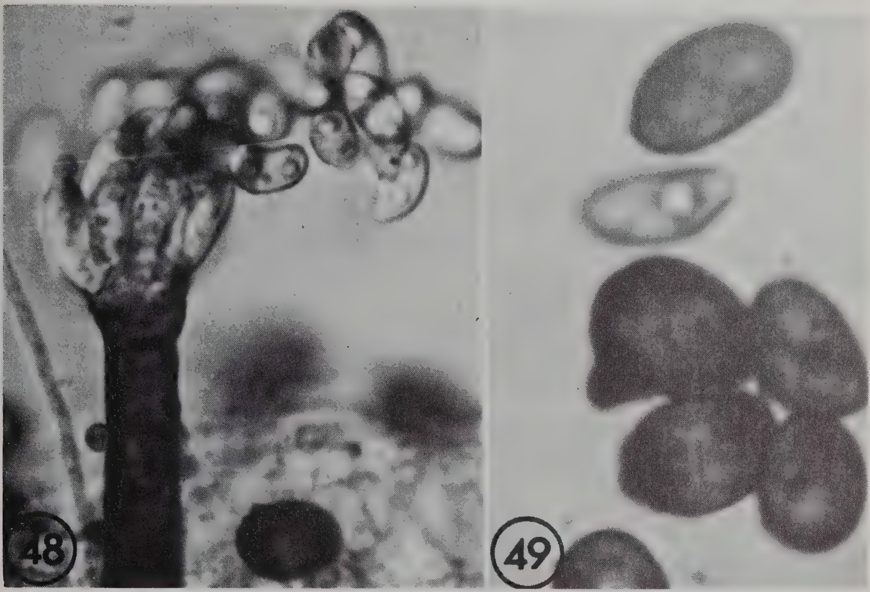
Figures 45-49.

Growth on CMA somewhat restricted, reaching 3 cm in diameter in 2 weeks. The surface of colony downy, orange at first, becoming dark granulate at the central part of the colony as conidia develop. Reverse stained bright orange. Conidia produced abundant a week after inoculation of plates.

Conidiophores determinate, macronematous, erect, straight or slightly curved, simple, 1-2 septate, smoke gray to black, smooth-walled, up to 190 μm long, 5-7 μm wide, slightly enlarged at the apex which bears terminal phialides in a whorl of 8-20 around a central phialides.



Figures 45-47. *Stachybotrys oenanthes* ATCC 22844. 45. Conidiophores with phialides and phialoconidia. ca. X 1,000. 46. Phialides and phialoconidia. ca. X 2,000. 47. Mature phialoconidia. ca. X 2,000.

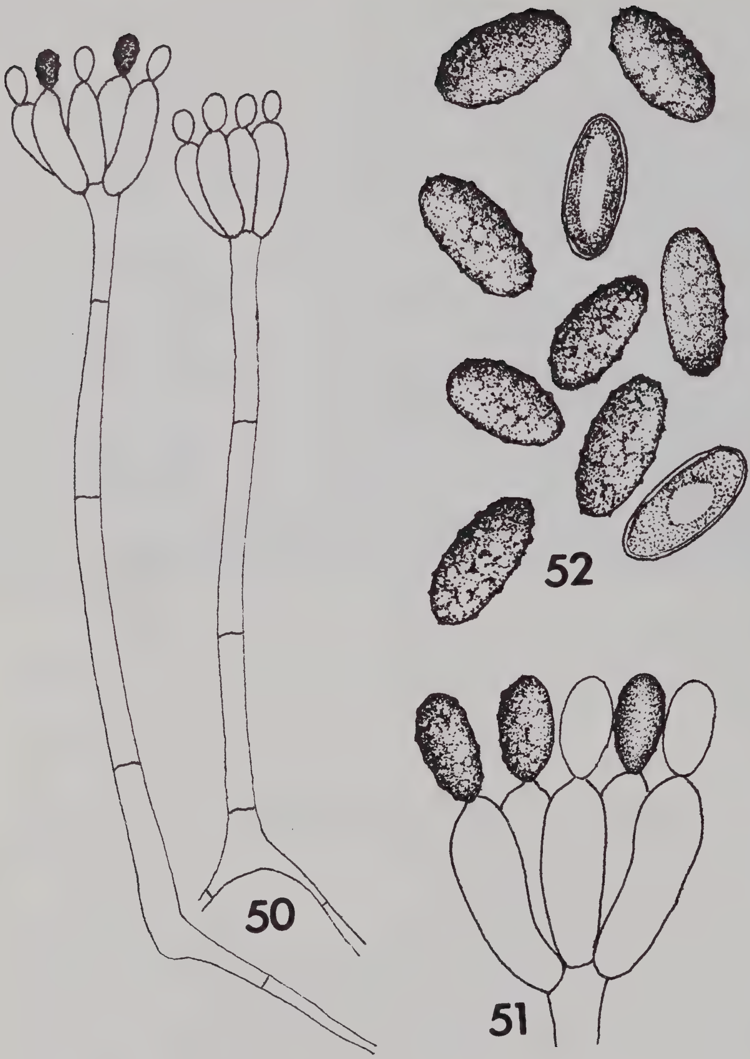


Figures 48-49. *Stachybotrys oenanthes* ATCC 22844.
48. Phialides and immature phialoconidia. ca. X 1,500.
49. Mature phialoconidia. ca. X 2,000.

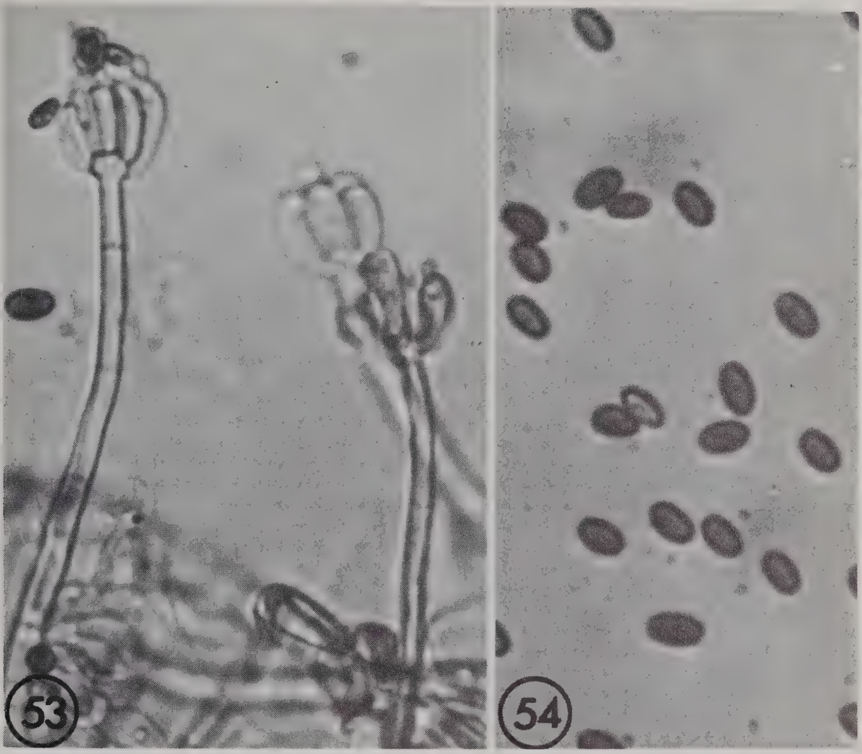
Phialides enteroblastic, determinate, discrete, unicellular, cylindrical, smoke gray to black, smooth-walled, 10-20 X 5-7 μm, with conspicuous collarettes.

Phialoconidia acrogenous, arising singly and successively as separate units, aggregated in slimy masses, at first hyaline and smooth-walled, when mature smoke gray to black, heavily verrucose, ovoid to reniform, sometimes obliquely attenuate at the base, 9-10 X 5-7 μm.

REMARKS: The strain ATCC 22844 (=IMI 16,185) studied is the type culture isolated by M. B. Ellis (1971) from dead stems of *Oenanthe crocatae* in Quernsey. It grows and sporulates on CMA at temperatures in the range of 10 to 24 C. The upper limit of temperature for spore germination is 30 C. No production of clearing on the cellulose agar medium by growth indicates that it is not a cellulose-decomposing fungus.



Figures 50-52. *Stachybotrys parvispora* ATCC 18877. 50. Conidiophores with phialides and phialoconidia. ca. X 1,000. 51. Phialides and phialoconidia. ca. X 3,000. 52. Mature phialoconidia. ca. X 3,000.



Figures 53-54. *Stachybotrys parvispora* ATCC 18877.
53. Growth habit of conidiophores. ca. X 1,000.
54. Phialoconidia. ca. X 1,000.

Stachybotrys parvispora Hughes, CMI Mycol. Papers 48: 74. 1952.

Figures 50-54.

Growth on cornmeal agar somewhat restricted, reaching 4 cm in diameter in 3 weeks. Colonies felty to silky, white at first, becoming olive green in areas of copious conidial production. Margin of colony distinct, white, with compact hyphae. Reverse stained light orange. Conidia produced in abundance a week after inoculation of plates.

Conidiophores determinate, macronematous, solitary or in groups, erect, straight or slightly curved, simple, occasionally branched, 3-5 septate, hyaline, smooth-walled, up to 200 μm long, 2-5 μm wide, the basal cell slightly inflated, attenuated toward the tip, slightly enlarged at the apex which bears terminal phialides in a whorl of 4-10 around a central phialide.

Phialides enteroblastic, determinate, discrete, clustered in a verticillate arrangement, unicellular, subclavate, hyaline, smooth-walled, 8-11 X 3-4 μm, with conspicuous collarettes.

Phialoconidia acrogenous, arising singly and successively as separate units, aggregated in slimy masses, at first hyaline, when mature, dark olive gray, more or less opaque, coarsely roughened, unicellular, ovate, 5-6 X 3-3.5 μm.

REMARKS: *Stachybotrys parvispora* was originally described by Hughes (1952) from dead leaves of *Ananas*, *Ficus* and *Setariae* from the Gold Coast of tropical Africa. It is readily recognized by the small dark olive phialoconidia 3 to 6 μm long by 3 to 3.5 μm wide. The strains ATCC 18877 (=IMI 62,388) and ATCC 18876 (=IMI 106,334) studied were secured from the Commonwealth Mycological Institute; the former was isolated from soil in Congo and the latter from root of *Hevea* in Malaya. Both fit Hughes' original description.

The growth temperature range for ATCC 18877 is narrow, 20 to 30 C. However, the upper limit of temperature for conidial germination is 37 C. No clearing of the cellulose agar medium by growth of this fungus indicates that it is unable to decompose cellulose.

Stachybotrys theobromae Hansf., Proc. Linn. Soc. Lond. 155: 45. 1943.

Figures 55-60.

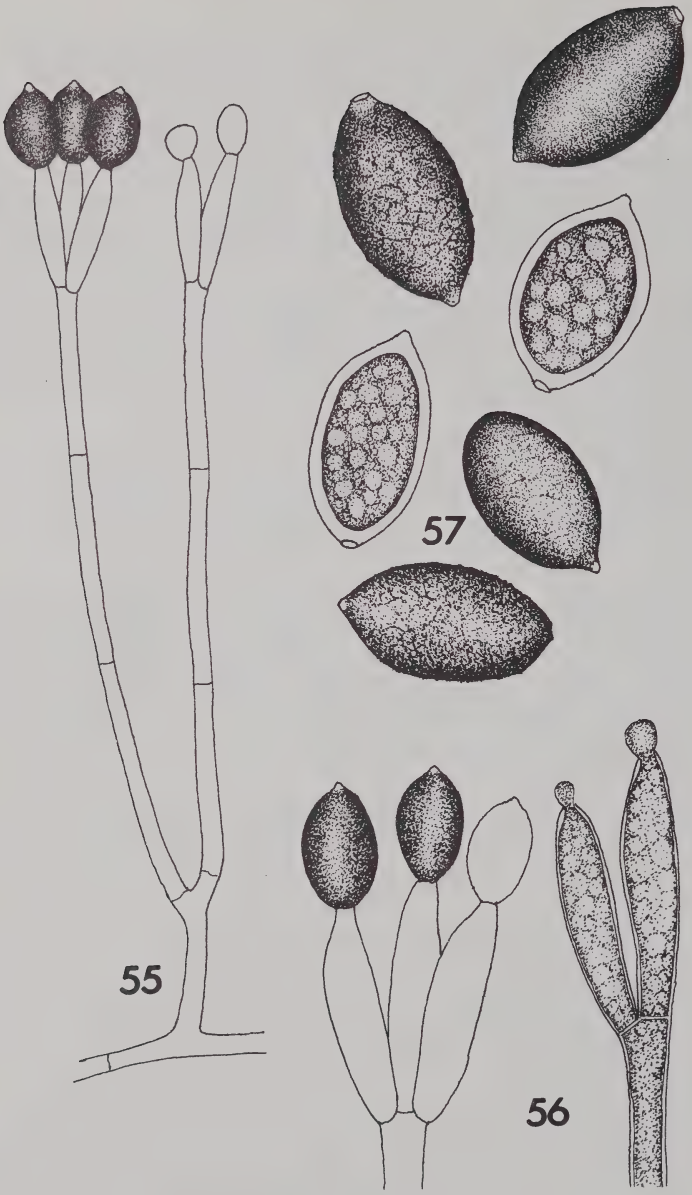
Growth on potato dextrose agar covering the Petri-dish plates in 3 weeks, fleecy to velvet lanose with various degrees of luxuriance, gleaming white, becoming dark granulate as conidial production commences. Margin of colony distinct, lobed, peripheral hyphae dispersed. No staining of medium in advance of mycelium. Reverse at first uncolored, later becoming olive. Conidia produced in abundance two weeks after inoculation of plate.

Conidiophores determinate, macronematous, solitary or in groups, erect, straight or slightly curved, simple or irregularly branched, 6-14 septate, hyaline, length variable, up to 400 µm long, 3-5 µm wide, the basal cell slightly inflated, attenuate toward the tip, smooth throughout the length, slightly enlarged at the apex which bears a terminal phialide or in a group of 3-4 around a central phialide.

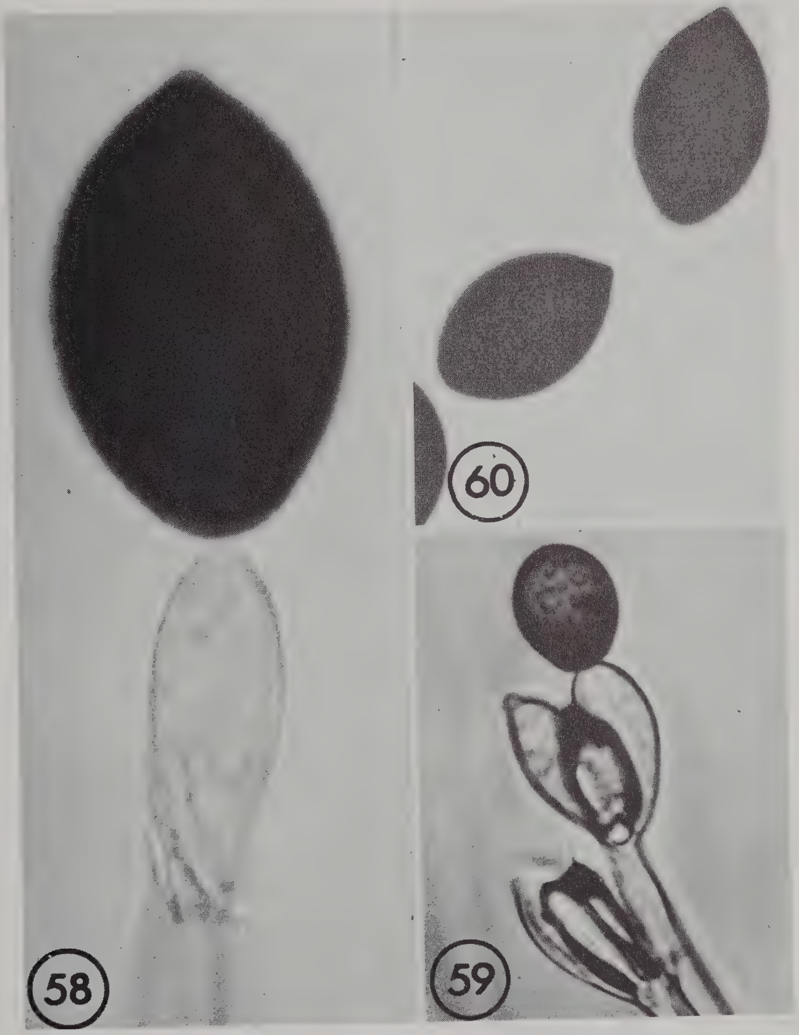
Phialides enteroblastic, determinate, discrete, unicellular, subclavate, hyaline, smooth-walled, 15-23 X 4-5 µm, with conspicuous collarettes.

Phialoconidia acrogenous, arising singly and successively as separate units, aggregated in slimy masses, at first hyaline and smooth-walled, when mature, dark green, more or less opaque, coarsely roughened, unicellular, oval, 16-28 X 12-16 µm, usually with a well-marked apical apiculus.

REMARKS: The fungus was first discovered by Hansford (1943) on branches of *Theobroma cacao* L. in Uganda. The phialoconidia are described as 15-18 X 20-28 µm on phialides 7-10 X 12-28 µm. Hughes (1952) reported several collections from the Gold Coast on twigs of *Hura crepitans* L. and on branches and dead dry empty pods of *Theobroma cacao*. Hughes described and illustrated the phialoconidia with a well-marked basal apiculus. Hughes' figures were reproduced by Verona and Mazucchetti (1968). However, careful examinations of strain ATCC 18905 (=IMI 105,321) which was originally isolated by T. H. Williams from *Theobroma cacao* in Tuaran. Sabah, Malaysia, and the type specimen deposited with the Kew Herbarium (K) indicate that the apiculus is apical instead of basal. This species differs from other *Stachybotrys* species studied by having large, dark green phialoconidia on hyaline phialides and conidiophores.



Figures 55-57. *Stachybotrys theobromae* ATCC 18905. 55. Conidiophores with terminal phialides and phialoconidia. ca. X 500. 56. Phialides and phialoconidia. ca. X 800. 57. Phialoconidia with a well-marked apical apiculus. ca. X 1,200.



Figures 58-60. *Stachybotrys theobromae* ATCC 18905. 58. Phialide bearing a terminal phialoconidium with a well-marked apical apiculus. ca. X 2,300. 59. Phialides. ca. X 800. 60. Mature phialoconidia. ca. X 1,000.

Stachybotrys crassa El. Marchal (1895) and *S. nilagirica* Subramanian (1957) are also described as having large globose phialoconidia, 16-18 µm in the former and 15.4-28 µm in the latter. Unfortunately, neither have been cultured. However, the original descriptions and figures of both species show that they are quite distinct from *S. theobromae* in which the phialoconidia are oval and with a well-marked apical apiculus.

Stachybotrys crassa has been reported only from the type collection on dung in Belgium. Bisby (1943) in his review of the genus considered it a doubtful species unless the type specimen can be examined, or the species rediscovered.

ATCC 18905 grows and sporulates well on potato dextrose agar at temperatures in the range of 20 to 30 C. However, the maximum temperature for conidial germination is 37 C. The fungus is unable to clear the cellulose agar medium, indicating that it is not a cellulose-decomposing fungus.

Memnoniella echinata (Riv.) Galloway, Trans. Brit. Mycol. Soc. 18: 165. 1933.

≡ *Penicillium echinatum* Riv., Dei Parassiti Vegetali, p. 451. 1873.

≡ *Haplographium echinatum* (Riv.) Sacc., Syll. Fung. 4: 307. 1886.

≡ *Stachybotrys echinata* (Riv.) Smith, Trans. Brit. Mycol. Soc. 45: 392. 1962.

= *Periconia papyrogena* Sacc., Michelia 1: 273. 1878.

≡ *Stachybotrys papyrogena* (Sacc.) Sacc., Fungi ital. Tab. 900. 1881.

≡ *Sterigmatobotrys papyrogena* (Sacc.) Oud., Nederl. Kruidk. Arch., II, 4: 548. 1886.

= *Memnoniella aterrima* Höhnel, Zbl. Bakt. (Abt. II) 60: 16. 1923.

Figures 61-66.

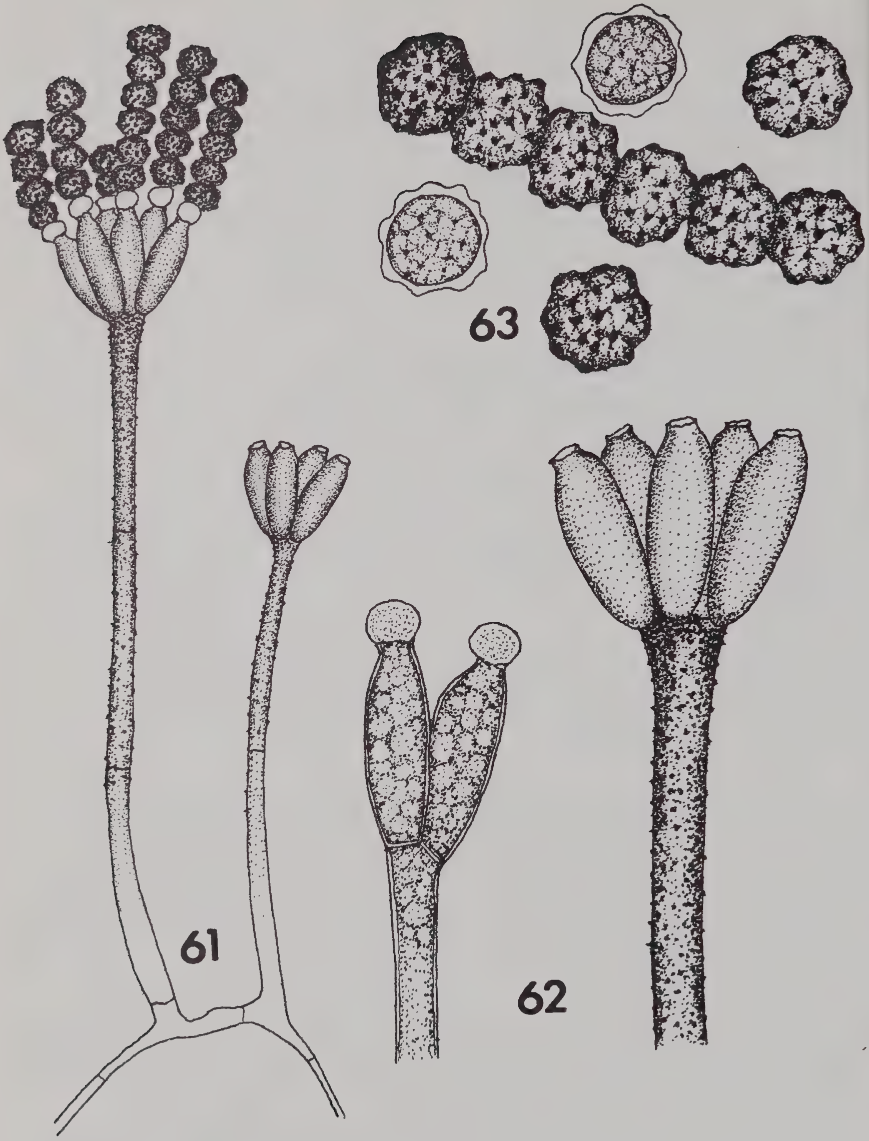
Growth on cornmeal agar somewhat restricted, reaching 5 cm in diameter in 3 weeks, at first submerged and colorless, becoming downy and dark granulate as conidial production commences. Margin of colony not distinct, with submerged hyphae and few conidia. Reverse stained yellowish brown to brownish gray. Conidia produced in abundance 2 days after inoculation on agar plates and sterilized rabbit dung.

Conidiophores determinate, macronematous, solitary or in groups, erect, straight or slightly curved, unbranched, 1-3 septate, at first hyaline, later olivaceous, 70-90 μm long, 3-5 μm wide, the basal cell slightly inflated, sometimes minutely rough-walled throughout the length, sometimes more or less smooth throughout, slightly enlarged at the apex which bears terminal phialides in a whorl of 6-9 around a central phialide.

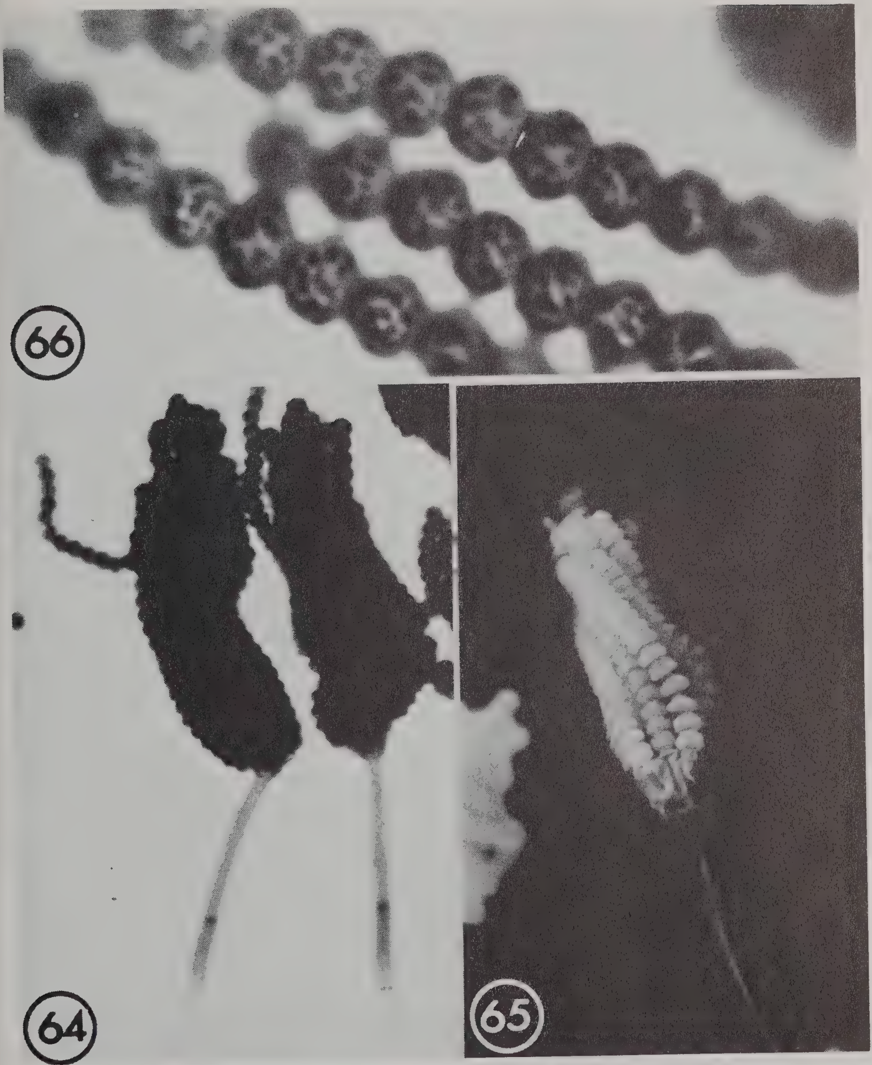
Phialides enteroblastic, determinate, discrete, unicellular, pale olivaceous, obovate or ellipsoid, smooth-walled, 7-10 X 3-4 μm with conspicuous wide terminal collarettes.

Phialoconidia acrogenous, arising in basipetal succession and remaining attached to one another by a common septum in long persistant chains, at first hyaline and smooth-walled, when mature, dark olive gray, more or less opaque, coarsely warted, continuous, octagonal-globose in side view and circular in outline in end view, dry (not in slime), 3-6 μm in diameter.

REMARKS: Rivolta (1873) first discovered this fungus on hay and wheat culms in Northern Italy and described it as *Penicillium echinatum* Rivolta (not *P. echinatum* Dale). The description and figure given by Rivolta indicated that the distinguishing feature of this fungus was the black catenulate phialoconidia resembling those of *Aspergillus niger* and the conidiophores with penicillate heads resembling those of *Stachybotrys*. However, Saccardo (1186) later transferred Rivolta's species from *Penicillium* Link to *Haplographium* Berk. & Br. which is characterized by slimy masses of blastoconidia borne singly at the apex of dark conidiophores with penicillate heads (Barron, 1968).



Figures 61-63. *Memnoniella echinata* ATCC 11974.
61. Conidiophores with terminal phialides and phialoconidia in chains. ca. X 600. 62. Phialides. ca. X 1,200.
63. Phialoconidia. ca. X 2,400.



Figures 64-66. *Memnoniella echinata* ATCC 11974. 64. Growth habit of conidiophores. ca. X 200. 65. Scanning electron micrograph of phialides with phialoconidia in chains. ca. X 600. 66. Mature phialoconidia in chains. Note a coarsely warted surface. ca. X 2,000.

Unaware of Rivolta's work, Höhnel (1923) described this species based on his isolate from cotton yarn in Vienna and designated it as *Memnoniella aterrima* gen. and sp. nov. Galloway (1933) critically reviewed Rivolta's and Höhnel's works and accepted Höhnel's genus, making the combination *M. echinata* (Riv.) Galloway for his isolate obtained as an air contaminant in the laboratory. He also pointed out that this fungus is closely related to *Stachybotrys* from which it is distinguished by the globose phialoconidia borne in chains. Further examinations of the type material of *M. aterrima* in the Farlow herbarium by Linder (Galloway, 1933) and by White *et al.* (1949) have confirmed Galloway's decision that *P. echinatum* and *M. aterrima* belong to the same species.

Upon reexamination of Galloway's original culture of *M. echinata*, Bisby (1943) suggested the possibility that *M. echinata* might be an unusual or abnormal form of *Stachybotrys subsimplex* in which slime production was reduced to allow retention of the conidia in chains. However, Bisby (1945) later recognized *M. echinata* as being distinctive from *S. subsimplex* after studies of several new cultures from different localities. Although Zuck (1949) found that some isolates of *Memnoniella* occasionally producing a *Stachybotrys*-like phase much like the description of *S. subsimplex sensu* Bisby (1943), he considered *M. echinata* a distinct species since some of his cultures had remained stable for eight years in the characters Galloway listed for *M. echinata.* Padwick (1945) accepted *M. echinata* and redescribed it based on his isolate from cotton cardage in Cawnpore, India. Padwick's description was recently reproduced by Verona and Mazzucchetti (1968).

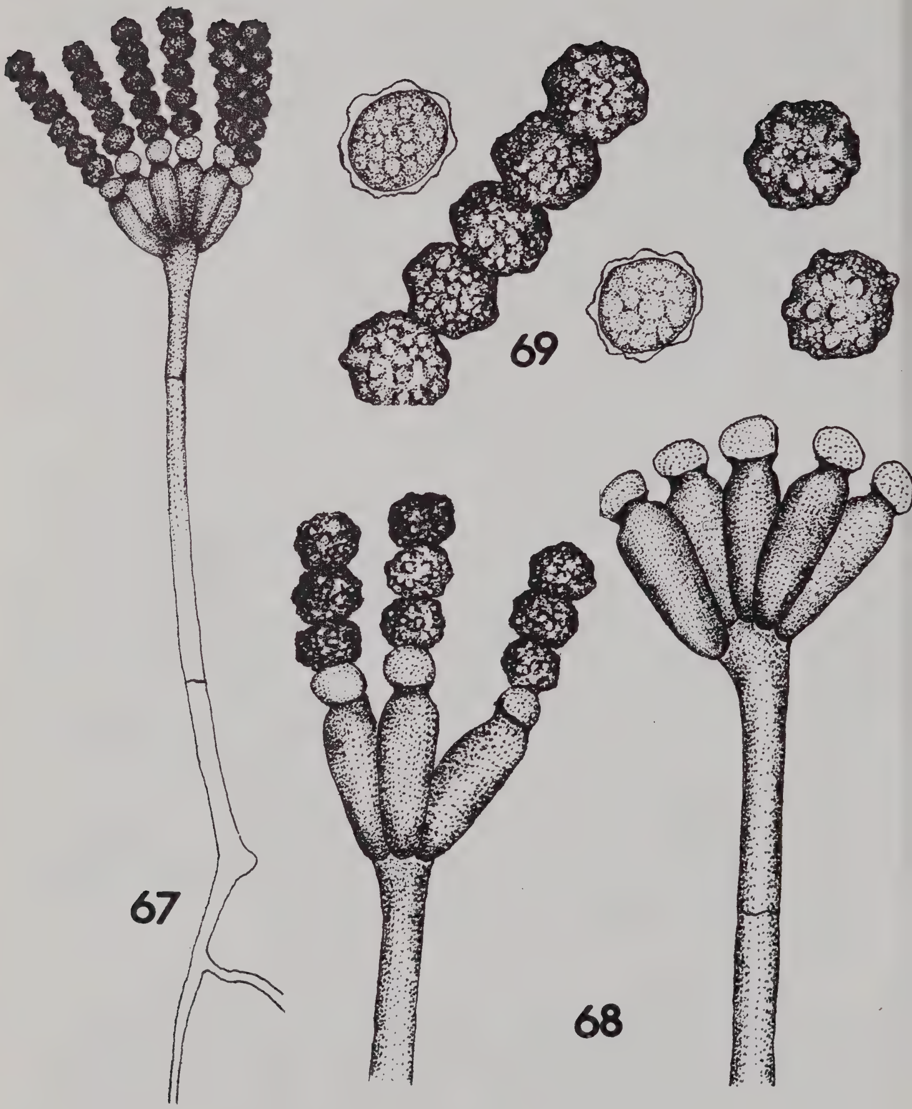
The species concept of *S. subsimplex* has recently been clarified by Deighton (1960) who points out that the type material (IMI 10,941) has globose catenulate phialoconidia resembling those of *M. echinata* from which it differs in its larger phialoconidia. It is obviously not a *Stachybotrys*-like phase of *M. echinata* but a distinct species of *Memnoniella*. Deighton therefore made the new combination *Memnoniella subsimplex* (Cooke) Deighton. Nonetheless, Smith (1962) would relegate *Memnoniella* to synonymy with *Stachybotrys*, making a new combination *Stachybotrys echinata* (Riv.) Smith for *M. echinata* (Riv.) Galloway. Because the culture studied in the present work also appears to remain stable in the characters defining *Memnoniella*, we recognize *Memnoniella* and *Stachybotrys* as distinct genera but very closely related.

The nomenclatural synonyms of *Memnoniella echinata* listed above are compiled from the opinion of Smith (1962).

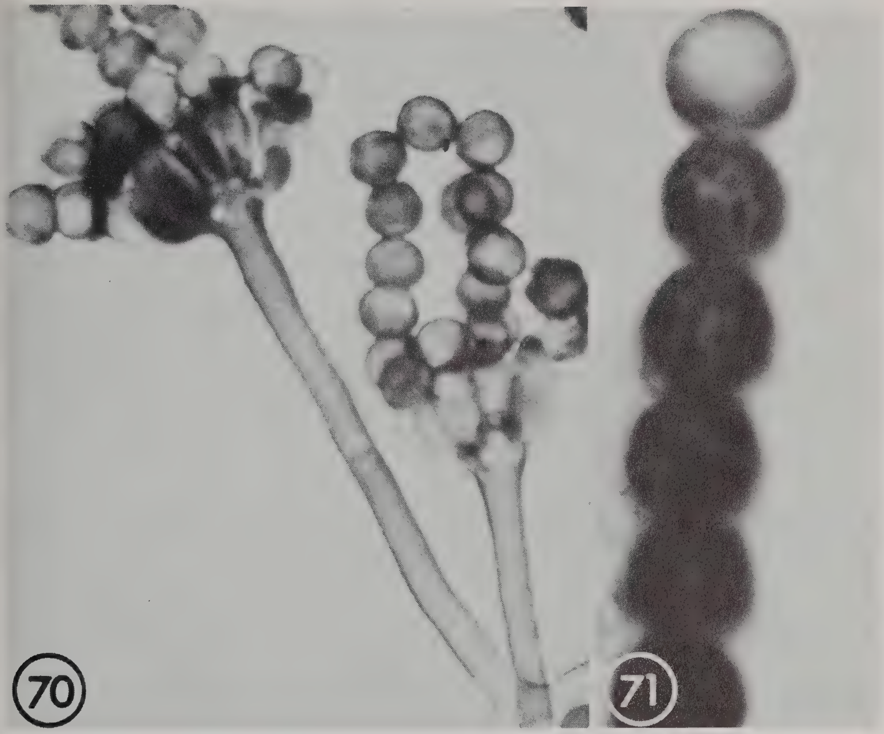
An excellent report on the history, distribution and economic significance of *M. echinata* has been published by White, Yeager and Shotts (1949). From an analysis of samples of deteriorated fabrics received from numerous military installations around the tropical belt of the world and from the United States, and after examinations of isolates from such samples, and of herbarium specimens, they concluded that *M. echinata* is a tropical cellulose-loving species that is able to utilize cellulose as a major carbon source.

The strain ATCC 11974 studied was obtained from E. G. Simmons as QM 1225 of the U. S. Army Natick Laboratories, Natick, Massachusetts. This strain was also included by McQuade (1963) in his studies of morphogenetic responses of fungi to factorily arranged variation in concentrations of NH_4Cl, K_2HPO_4 and glucose. It grows and sporulates well on cornmeal agar at temperatures in the range of 15 to 30 C. The upper limit of temperature for conidial germination is 37 C. Production of clearing by growth on the cellulose agar medium reveals that it is a strong cellulose-decomposing fungus. ATCC 11974 is being used for fungus resistance tests in U. S. military specifications. The other two strains (ATCC 22697 and ATCC 22698) studied were isolated by T. Matsushima from forest soil in Papua-New Guinea.

Two additional species of *Memnoniella* have been reported from India. *Memnoniella levispora* Subramanian (1954) has conidia with smooth walls, 3-7 μm in diameter and also been recovered from Pakistan (Ellis, 1971). *Memnoniella zingiberis* Rao has conidia with roughened walls, 4.4-6.8 μm in diameter. According to the description and figure given by Rao (1962), it is quite possible that *M. zingiberis* is a synonym of *M. echinata*. Unfortunately, neither *M. levispora* nor *M. zingiberis* is available in culture.



Figures 67-69. *Memnoniella subsimplex* ATCC 18838. 67. Conidiophore with terminal phialides and phialoconidia in chains. ca. X 500. 68. Phialides. ca. X 1,000. 69. Mature phialoconidia. ca. X 1,600.



Figures 70-71. *Memnoniella subsimplex* ATCC 18838.
70. Phialides with phialoconidia in chains. ca. X 800.
71. Mature phialoconidia in chains. Note a coarsely warted surface. ca. X 2,000.

Memnoniella subsimplex (Cooke) Deighton, CMI Mycol. Papers 78: 5. 1960.

≡ *Stachybotrys subsimplex* Cooke, Grevillea 12: 33. 1883.

= *Haplographium musae* Sawada, Nat'l. Taiwan Univ. Coll. Agric. Spec. Publ. 8: 193. 1959.

Figures 67-71.

Growth on cornmeal agar somewhat restricted, reaching 4 cm in diameter in 3 weeks, submerged, colorless to yellowish pink. Central parts of old colonies becoming downy and dark granulate as conidial production commences. Margin of colony not distinct, hyaline, with submerged hyphae. Reverse stained orange to brown. Conidia produced in abundance a week after inoculation of the plate.

Conidiophores determinate, macronematous, solitary or in groups, erect, straight or slightly curved, unbranched, 1-3 septate at first hyaline, later olivaceous, up to 220 µm long, 3-4 µm wide, the basal cell slightly inflated, sometimes minutely rough-walled throughout the length, sometimes more or less smooth throughout, slightly enlarged at the apex which bears terminal phialides in a whorl of 5-12 around a central phialide.

Phialides enteroblastic, determinate, discrete, unicellular, ellipsoid, olivaceous, smooth-walled, 12-15 X 5-6 µm, with conspicuous collarettes.

Phialoconidia acrogenous, arising in basipetal succession and remaining attached to one another by a common septum in long persistent chains, at first hyaline and smooth-walled, when mature, dark olive gray, more or less opaque, coarsely warted, continuous, octagonal-globose in side view and circular in outline from the end view, dry (not in slime), 6-9 µm in diameter.

REMARKS: In reviewing the genus *Stachybotrys*, Bisby (1943) tentatively emended *S. subsimplex* Cooke to include *Memnoniella echinata* (Riv.) Galloway. Zuck (1946) later amplified Bisby's suggestion, indicating that *M. echinata* in culture may sometimes produce a *Stachybotrys*-like phase similar to the description of *S. subsimplex sensu* Bisby. As pointed out by Bisby and Ellis (1949), this leaves the name *Stachybotrys* as doubtful, unless it refers to the *Stachybotrys*-like phase of *Memnoniella echinata*.

However, the type material of *S. subsimplex* in the Kew Herbarium (K) was reexamined by Deighton (1960) who found that it is not a *Stachybotrys*-like phase of *M. echinata* but a distinct species of *Memnoniella* . He therefore transferred Cooke's species from *Stachybotrys* to *Memnoniella* as *M. subsimplex* (Cooke) Deighton. Phialoconidia of this fungus differ from those of *Stachybotrys chartarum* (as *S. atra*) and other *Stachybotrys* species in being slightly flattened along the axis from the base to the apex instead of being elongated along this axis, and in not sliming down at once into a mucilaginous mass, but instead, remaining for a period attached in long chains. Deighton also pointed out that it is obviously closely related to *M. echinata* from which it differs in its larger phialoconidia, (6)7-8(9) µm in diameter, as against 4-5.5(6) µm in *M. echinata*.

The fungus commonly occurs on dead *Musa* leaves and on dead parts of other host plants in the tropics (Deighton, 1960; Sawada, 1959). It was also recorded by Joffe (1967) from soil in a citrus fertilizer trial in Israel and by Matsushima (1971a) from forest soil in the Solomon Islands.

The strain ATCC 18838 studied was obtained from K. Tubaki of the Institute for Fermentation, Osaka, Japan, as *Stachybotrys echinata* (Riv.) Smith (IFO 7525). ATCC 22699 and ATCC 22700 both were isolated by T. Matsushima from forest soil in British Solomon Islands. Morphologically, they fit with Deighton's description of *M. subsimplex* and are readily distinguishable by the predominance of catenulate phialoconidia, and their size. During the course of the present work, we have not seen a *Stachybotrys*-like phase in these cultures. The growth temperature range of ATCC 18838 is very narrow, 24 to 30 C. The upper limit of temperature for conidial germination is also 30 C. The fungus is able to decompose cellulose and utilize it as a sole carbon source.

ACKNOWLEDGMENTS

We wish to thank Dr. Agnes H. S. Onions, of Commonwealth Mycological Institute, Kew, England, for the loan of the dried type culture of *Stachybotrys atra* var. *microspora* and Dr. P. S. Green, of the Royal Botanic Garden, Kew, England, for the type specimens of *S. kampalensis*, *S. nephrospora* and *S. theobromae*. Thanks are also due to all the contributors who deposited the cultures studied in the ATCC Mycology Collection.

Appreciation is extended to Dr. J. L. Crane, of the Illinois Natural History Survey, Urbana, Illinois, for his painstaking review of the manuscript, bibliographic assistance and for the scanning electron micrographs of the phialoconidia of *S. chartarum* and *Memnoniella echinata*.

We are grateful to Dr. Emory G. Simmons, former chairman of the ATCC Advisory Committee of the Collection of Fungi, to Dr. Chester R. Benjamin and Dr. Constantine J. Alexopoulos, former members of the ATCC Board of Trustees, for their critical review of the manuscript.

We are also grateful to Professor Richard P. Korf for his careful editing and final arrangement of the manuscript.

This work was supported in part by National Science Foundation Grants BMS75-06286 and DEB75-06286 A01 and by Brown-Hazen Grant BH 846 from Research Corporation, New York.

LITERATURE CITED

ALBERTINI, I. B., and L. D. SCHWEINITZ. 1805. Conspectus Fungorum in Lusatiae superioris agro Niskiensi crescentium. Lipsiae 29: 34.

BAMBURG, J. R., and F. M. STRONG. 1971. 12-13-epoxy epoxytrichothecenes. p. 207-292. *In* S. Kadis, A. Ciegler, and S. Ajl (eds.) *Microbial Toxins*, Vol. VII. Academic Press, New York.

BARRON, G. L. 1961. Studies on species of *Helicodendron, Oidiodendron* and *Stachybotrys* from soil. Can. J. Bot. 39: 1563-1571.

BARRON, G. L. 1962. *Stachybotrys aurantia* sp. nov. from soil. Can. J. Bot. 40: 257-261.

BARRON, G. L. 1964. A note on the relationship between *Stachybotrys* and *Hyalostachybotrys*. Mycologia 56: 313-316.

BARRON, G. L. 1968. *The Genera of Hyphomycetes from Soil.* The Williams & Wilkins Co., Baltimore, 364 pp.

BERKELEY, J. M., and C. E. BROOME. 1871. Notices of British fungi. Ann. Mag. Nat. Hist. Ser. 4, 7: 425.

BISBY, G. R. 1943. *Stachybotrys.* Trans. Brit. Mycol. Soc. 26: 133-143.

BISBY, G. R. 1945. *Stachybotrys* and *Memnoniella.* Trans. Brit. Mycol. Soc. 28: 11-12.

BISBY, G. R., and M. B. ELLIS. 1949. *Stachybotrys dichroa* Grove. Trans. Brit. Mycol. Soc. 32: 158-161.

BODON, L., and M. PALYUSIK. 1970. Cytoxicity of toxic extracts from the fungus *Stachybotrys alternans.* Acta Vet. Acad. Sci. Hung. 20: 289-294.

BONDIETTI, E., J. P. MARTIN, and K. HAIDER. 1971. Influence of nitrogen source and clay on growth and phenolic polymer production by *Stachybotrys* species, *Hendersonula toruloides,* and *Aspergillus sydowi.* Soil Sci. Soc. Amer. Proc. 35: 917-922.

BOJOVIĆ-CVETIĆ, D., and R. VUJIČIĆ. 1974. Ultrastructure of conidiophores in *Aspergillus flavus*. Trans. Br. Mycol. Soc. 63: 131-135.

BOOTH, C. 1957. Studies of Pyrenomycetes. II. *Melanopsamma pomiformis* and its *Stachybotrys* conidia. CMI Mycol. Papers 68: 16-27.

BUCKLEY, P. M., T. D. WYLLIE, and J. E. DEVAY. 1969. Fine structure of conidia and conidium formation in *Verticillium albo-atrum* and *V. nigrescens*. Mycologia 61: 240-250.

BUSTON, H. W., and S. N. BASU. 1948. Some factors affecting the growth and sporulation of *Chaetomium globosum* and *Memnoniella echinata*. J. Gen. Microbiol. 2: 162.

BUTT, Z. L., and A. CHAFFAR. 1972. Inhibition of fungi, Actinomycetes and bacteria by *Stachybotrys atra*. Mycopath. Mycol. Appl. 47: 241-251.

CAMPBELL, R. 1972. Ultrastructure of conidium ontogeny in the Deuteromycete fungus *Stachybotrys atra* Corda. New Phytol. 71: 1143-1149.

CAMPBELL, R. 1974. The ultrastructure of the formation of chains of conidia in *Memnoniella echinata*. Mycologia 67: 760-769.

CARROLL, G. C., and F. E. CARROLL. 1974. The fine structure of conidium development in *Phialocephala dimorphospora* Can. J. Bot. 52: 2119-2128.

COCHRANE, V. W. 1958. *Physiology of Fungi*. John Wiley & Sons, Inc., New York, 524 pp.

CORDA, A. C. I. 1837. *Icones Fungorum hucusque cognitorum*. I. p. 21, f. 278B.

DEIGHTON, F. C. 1960. African fungi. I. CMI Mycol. Papers 78: 1-43.

DROBOTKO, V. G. 1945. Stachybotryotoxicosis, a new disease of horses and man. Ann. Rev. Soviet Med. 2: 238-242.

ELLIS, M. B. 1971a. *Dematiaceous Hyphomycetes.* Commonwealth Mycological Institute, Kew, England, 608 pp.

ELLIS, M. B. 1971b. Dematiaceous Hyphomycetes. X. CMI Mycol. Papers 125: 1-30.

EMMONS, C. W., C. H. BINFORD, and J. P. UTZ. 1970. *Medical Mycology.* 2nd ed. Lea & Febiger, Philadelphia. 508 pp.

EPPLEY, R. M., and W. J. BAILEY. 1973. 12-13-epoxy-Δ^9-trichothecenes as the probable mycotoxins responsible for stachybotryotoxicosis. Science 181: 758-760.

FERRARIS, T. 1909. Osservazioni micrologiche su specie del gruppo Hyphales (Hyphomycetes). Ann. Mycol. 7: 273-286.

FERRARIS, T. 1912. *Flora Italica, Hyphales.* p. 246.

FILIP, Z., K. HAIDER, and J. P. MARTIN. 1972a. Influence of clay minerals on growth and metabolic activity of *Epicoccum nigrum* and *Stachybotrys chartarum.* Soil Biol. Biochem. 4: 135-145.

FILIP, Z., K. HAIDER, and J. P. MARTIN. 1972b. Influence of clay minerals on the formation of humic substances by *Epicoccum nigrum* and *Stachybotrys chartarum.* Soil Biol. Biochem. 4: 147-154.

FLETCHER, J. 1971. Conidium ontogeny in *Penicillium.* J. Gen. Microbiol. 67: 207-214.

FORGACS, J. 1965. Stachybotryotoxicosis and moldy corn toxicosis. p. 87-93. *In* G. N. Wogan (ed.), *Mycotoxins in Foodstuffs.* MIT Press, Cambridge, Massachusetts.

FORGACS, J. 1972. Stachybotryotoxicosis. p. 95-128. *In* S. Kadis, A. Ciegler, S. J. Ajl (eds.). *Microbial Toxins.* Vol. VIII. Academic Press, New York.

FORGACS, J., and W. T. CARLL. 1962. Mycotoxicoses. Adv. Vet. Sci. 7: 273-293.

FORGACS, J., W. T. CARLL, A. S. HERRING, and W. R. HINSHAW. 1958. Toxicity of *Stachybotrys atra* for animals. Trans. N. Y. Acad. Sci. 20: 787-808.

GALLOWAY, L. D. 1933. Note on an unusual mould fungus. Trans. Brit. Mycol. Soc. 18: 163-166.

GHIORSE, W. C., and E. R. EDWARDS. 1973. Ultrastructure of *Aspergillus fumigatus* conidia development and maturation. Protoplasma 76: 49-59.

GOOS, R. D. 1956. Classification of the Fungi Imperfecti Proc. Iowa Acad. Sci. 63: 311-320.

GRAY, W. D. 1971. *The Use of Fungi as Food and in Food Processing*. CRC Press, Cleveland, Ohio. 113 pp.

GREATHOUSE, G. A., D. E. KLEMME, and H. D. BARKER. 1942. Determining the deterioration of cellulose caused by fungi. Ind. Eng. Chem., Anal. Ed. 14: 614-620.

HAMMILL, T. M. 1972. Electron microscopy of phialoconidiogenesis in *Metarrhizium anisopliae*. Amer. J. Bot. 59: 317-326.

HAMMILL, T. M. 1974. Electron microscopy of phialides and conidiogenesis in *Trichoderma saturnisporum*. Amer. J. Bot. 61: 15-24.

HANLIN, R. T. 1976. Phialide and conidium development in *Aspergillus clavatus*. Amer. J. Bot. 63: 144-155.

HANSFORD, C. G. 1943. Contributions toward the fungus flora of Uganda. V. Fungi Imperfecti. Proc. Linn. Soc., Lond. 155: 34-67.

HÖHNEL, FRANZ VON. 1902. Fragmente zur Mycologie (I Mitteilung) Sitzungsber. Kaiser. Akad. Wiss. Wien, Mathem.-Naturwiss. Kl., Abt. I, 111: 987-1056.

HÖHNEL, FRANZ VON. 1923. *Memnoniella* Höhn. n.g. Centralbl. Bakt. 2, 60: 16-17.

HUGHES, S. J. 1952. Fungi from the Gold Coast. I. CMI, Mycol. Papers 48: 1-91.

HUGHES, S. J. 1953. Conidiophores, conidia and classification. Can. J. Bot. 31: 577-659.

HUGHES, S. J. 1958. Revisiones Hyphomycetum aliquot cum appendice de nominibus rejiciendis. Can. J. Bot. 36: 727-836.

JENSEN, C. W. 1912. Fungus flora of soil. Cornell Agr. Exp. Sta. Bull. 315: 414-501.

JERMYN, M. A. 1953. Fungal cellulases. III. *Stachybotrys atra*. Growth and enzyme production on non-cellulosic substrates. Aust. J. Biol. Sci. 6: 48-49.

JERMYN, M. A. 1955a. Fungal cellulases. IV. Production and purification of an extracellular β-glucosidase *Stachybotrys atra*. Austral. J. Biol. Sci. 8: 541-562.

JERMYN, M. A. 1955b. Fungal cellulases. V. Enzymic properties of *Stachybotrys atra* β-glucosidase. Austral. J. Biol. Sci. 8: 563-576.

JERMYN, M. A. 1955c. Fungal cellulases. VI. Substrates and inhibitor specificity of β-glucosidase of *Stachybotrys atra*. Austral. J. Biol. Sci. 8: 577-602.

JERMYN, M. A. 1962. Acceptor competition as means of distinguishing between possible enzymic mechanisms using the β-glucosidase of *Stachybotrys atra*. Austral. J. Biol. Sci. 15: 248-261.

JERMYN, M. A. 1965a. Fungal cellulases. XI. The nature of the inductive process for aryl β-glucosidase in *Stachybotrys atra*. Austral. J. Biol. Sci. 18: 387-415.

JERMYN, M. A. 1965b. Fungal cellulases. XII. Relation of the amino acid analyses of mycelium of *Stachybotrys atra* and of its β-glucosidase to the *S*-aminoethyl-L-cysteine effect on induction. Austral. J. Biol. Sci. 18: 417-423.

JERMYN, M. A. 1965c. Fungal cellulases. XIII. Specificity of the induction of the β-glucosidase of *Stachybotrys atra*. Austral. J. Biol. Sci. 18: 425-436.

JERMYN, M. A. 1966a. Fungal cellulases. XVII. The behaviour of t-butyl alcohol, pinacol and methanol as acceptors for the β-glucosidase of *Stachybotrys atra*. Austral. J. Biol. Sci. 19: 927-933.

JERMYN, M. A. 1966b. Fungal cellulases. XIX. Polyhydroxylic acceptors for the β-glucosidase of *Stachybotrys atra*. Austral. J. Biol. Sci. 19: 1153-1165.

JOFFE, A. Z. 1967. The mycoflora of a light soil in a citrus fertilizer trial in Israel. Mycopath. Mycol. Appl. 32: 209-230.

KENDRICK, W. B. 1971. *Taxonomy of Fungi Imperfecti*. Univ. of Toronto Press, Toronto, 309 pp.

KENDRICK, W. B., and J. W. CARMICHAEL. 1973. Hyphomycetes. p. 323-509. *In* G. C. Ainsworth, F. K. Sparrow, and A. S. Sussman (eds.), *The Fungi*. Vol. IVA. Academic Press, New York.

KORPINEN, E. L., M. KURKINEN, M. NUMMI, and T. M. ENARI. 1974. Studies of *Stachybotrys alternans*. III. Chromatographic separation and tissue culture toxicity test of stachybotrys toxins. Acta Path. Microbiol. Scand. Sect. B. 82: 7-11.

KORPINEN, E. L., and J. UOTI. 1974. Studies on *Stachybotrys alternans*. II. Occurrence, morphology and taxigenicity. Acta Path. Microbiol. Scand. Sect. B. 82: 1-6.

KORPINEN, E. L., and A. YLIMAKI. 1972. Discovery of taxicogenic *Stachybotrys chartarum* strains in Finland. Experientia (Basel) 28: 108-109.

LILLY, V. G., and H. L. BARNETT. 1951. *Physiology of the Fungi*. McGraw-Hill Co., New York, 464 pp.

LOWRY, R. J., T. L. DURKEE, and A. S. SUSSMAN. 1967. Ultrastructural studies of microconidium formation in *Neurospora crassa.* J. Bacteriol. 94: 1757-1763.

MARCHAL, ELIE. 1895. Champignons coprophiles de Belgique. VII. Bull. Soc. Roy. de Bot. Belgique 34: 125-149.

MARTIN, J. P., and K. HAIDER. 1969. Phenolic polymers of *Stachybotrys atra, Stachybotrys chartarum* and *Epicoccum nigrum* in relation to humic acid formation. Soil Sci. 107: 260-270.

MARSH, P. B., and I. BOLLENBACHER. 1946. Vitamin requirements of *Memnoniella* and *Stachybotrys*. Amer. J. Bot. 33: 245-249.

MARSH, P. B., K. BOLLENBACHER, M. L. BUTLER, and K. B. RAPER. 1949. The fungi concerned in fiber deterioration. II: Their ability to decompose cellulose. Text. Res. J. 19: 462-484.

MATHUR, B. L., and H. C. SANKHLA. 1966. A new variety of *Stachybotrys atra* from Rajasthan soil. Science & Culture 32: 93-94.

MATSUSHIMA, T. 1971a. *Microfungi of the Solomon Islands and Papua-New Guinea.* The Nippon Printing & Publishing Co., Osaka. 78 pp. + 169 figs. & 48 pls.

MATSUSHIMA, T. 1971b. Some interesting Fungi Imperfecti. Bull. Nat. Sci. Mus. Tokyo 14: 460-480.

MATSUSHIMA, T. 1975. *Icones Microfungorum A Matsushima Lectorum.* The Nippon Printing & Publishing Co., Osaka. 209 pp. + 415 pls.

McQUADE, A. B. 1963. Morphogenesis and nutrition in the *Memnoniella-Stachybotrys* group of fungi. J. Gen. Microbiol. 30: 429-435.

OLAH, G. M., and O. REISINGER. 1974. Etude ultrastructurale et cytochimique de l'appariel soprifere chez *Phialophora richardsiae.* Can. J. Bot. 52: 2473-2480.

OLIVER, P. T. P. 1972. Conidiophore and spore development in *Aspergillus nidulans*. J. Gen. Microbiol. 73: 45-54.

ORTIZ DE SERRA, M. I., F. J. SOWDEN, and M. SCHNITZER. 1973. Distribution of nitrogen in fungal "humic acids." Can. J. Soil Sci. 53: 125-127.

PADWICK, G. W. 1945. Notes on Indian fungi. III. CMI Mycol. Papers 12: 1-15.

PALYUSIK, M. 1970a. Biological test for the toxic substance of *Stachybotrys alternans*. Acta Vet. Acad. Sci. Hung. 20: 57-67.

PALYUSIK, M. 1970b. Experimental Stachybotryotoxicosis of young chicks. Sabouraudia 8: 4-8.

PERLMAN, D. 1948. On the nutrition of *Memnoniella echinata* and *Stachybotrys atra*. Amer. J. Bot. 35: 36-41.

PERLMAN, D. 1951. On the effects of biologically active agents on fungi at different stages of growth. Amer. J. Bot. 38: 652-658.

RAO, V. G. 1962. Some new records of Fungi Imperfecti from India. Sydowia 16: 41-45.

RAYSS, T., and S. BORUT. 1956. Contribution to the knowledge of soil fungi in Israel. Mycopath. Mycol. Appl. 10: 142-174.

REESE, E. T., R. G. H. SIU, and H. S. LEVINSON. 1950. Biological degradation of soluble cellulose derivatives. J. Bacteriol. 59: 485-497.

RIFAI, M. A. 1964. *Stachybotrys bambusicola* sp. nov. Trans. Brit. Mycol. Soc. 47: 269-272.

RIFAI, M. A. 1974. Another pink-spored and brown-stalked species of *Stachybotrys*. Reinwardtia 8: 537-540.

RIVOLTA, S. 1873. Dei Parassiti Vegetali, come introduzione allo studio delle malattie parassitarie e delle alterazioni dell' alimento delgi animali domestici. Torino, Italy. 592 pp.

RODERICKS, J. V., and R. M. EPPLEY. 1974. *Stachybotrys* and stachybotryotoxicosis. p. 181-197. *In* I. F. H. Purchase (ed.), *Mycotoxins.* Elsevier Scient. Publ. Co., New York.

ROQUEBERT, M. F., and M. M. ABADIE. 1973. Etude ultrastructurale de la sporogenèse chez un micromycète: *Stilbothamnium nudipes* Haum. C. R. Acad. Sci. Paris 276: 2883-2885.

SACCARDO, P. A. 1875. Fungi venti novi vel critici. Ser. II. Nuovo Giorn. Bot. Ital. 7: 299-329.

SACCARDO, P. A. 1878. Commentarium mycologicum fungos in primis italicos illustrans. Michelia I: 277-356.

SACCARDO, P. A. 1882. *Sylloge fungorum omnium hucusque cognitorum.* 1. Published by the author, Patavii, Italy. 767 pp.

SACCARDO, P. A. 1886. *Sylloge fungorum omnium hucusque cognitorum.* 4. Published by the author, Patavii, Italy. 807 pp.

SAWADA, K. 1959. *Descriptive Catalogue of Taiwan (Formosan) Fungi.* XI. National Taiwan Univ. Coll. Agric. Spec. Publ. No. 8. Taipei, Taiwan. 268 pp + 12 Pls.

SIMMONS, E. G. 1966. The theoretical bases for classification of the Fungi Imperfecti. Quart. Rev. Biol. 41: 113-123.

SMITH, G. 1962. Some new and interesting species of microfungi. III. Trans. Brit. Mycol. Soc. 45: 387-394.

SRINIVASAN, K. V. 1958. Fungi of the rhizosphere of sugarcane and allied plants. I. *Hyalostachybotrys* gen. nov. J. Indian Bot. Soc. 37: 334-342.

STAFLEAU, F. A., *et al.* (ed.). 1972. *International Code of Botanical Nomenclature* adopted by the Eleventh International Botanical Congress, Seattle, August 1969. Regnum Vegetabile 82: 1-426.

SUBRAMANIAN, C. V. 1954. Fungi Imperfecti from Madras. VI. J. Indian Bot. Soc. 33 : 36-42.

SUBRAMANIAN, C. V. 1957. Hyphomycetes. IV. Proc. Indian Acad. Sci. 46: 324-335.

SUBRAMANIAN, C. V. 1972. Conidial chains, their nature and significance in the taxonomy of Hyphomycetes. Curr. Sci. 41: 43-49.

THOM, C., H. HUMFELD, and H. P. HOLMAN. 1934. Laboratory tests for mildew-resistance of outdoor cotton fabrics. Am. Dyestuff. Reptr. 23: 581-586.

THOMAS, R. 1956. Fungal cellulases. VII. *Stachybotrys atra*: Production and properties of the cellulolytic enzyme. Austral. J. Biol. Sci. 9: 159-183.

TRAVERSO, J. B. 1912. *Flora Italica*, Pyrenomycetae. p. 685.

TRINCI, A. P., A. PEAT, and G. H. BANBURY. 1968. Fine structure in *Aspergillus giganteus* Wehmer. Ann. Bot. (Lond.) 32: 241-249.

TSUKAHARA, T. 1970. Electron microscopy of conidiospore formation in *Aspergillus niger*. Sabouraudia 8: 93-97.

TUBAKI, K. 1958. Studies on Japanese Hyphomycetes. V. Leaf and stem group with a discussion of the classification of Hyphomycetes and their perfect stages. J. Hattori Bot. Lab. 20: 142-244.

TUBAKI, K. 1963. Notes on the Japanese Hyphomycetes. I. *Chloridium, Clonostachy, Ishmospora, Pseudobotrytis, Stachybotrys* and *Stephanoma*. Trans. Mycol. Soc. Japan 7: 83-90.

VERONA, O., and G. MAZZUCCHETTI. 1968. *Microfunghi della cellulosa e della carta attivita' e inquadramento sistematico*. I. Generi "Stachybotrys" e "Memnoniella." Roma, Italy. 111 pp.

WHITE, W. L., R. T. DARBY, G. M. STECHERT, and K. SANDERSON. 1948. Assay of cellulolytic activity of molds isolated from fabrics and related items exposed in the tropic. Mycologia 40: 34-84.

WHITE, W. L., C. C. YEAGER, and H. SHOTTS. 1949. History, distribution and economic significance of the cellulose-destroying fungus *Memnoniella echinata*. Farlowia 3: 399-423.

WILSON, B. J. 1973. 12,13-epoxytrichothecenes: Potential toxic contaminants of foods. Nutrition Reviews 31: 169-172.

YOUATT, G. 1958. Fungal cellulases. IX. Growth of *Stachybotrys atra* on cellulose production of a β-glucosidase hydrolyzing cellobiose. Aust. J. Biol. Sci. 11: 209-217.

YOUATT, G., and M. A. JERMYN. 1959. Enzymes splitting β-glucosidic lindages in *Stachybotrys atra*. p. 397-409. *In* D. L. Ray (ed.), *Marine Boring and Fouling Organisms*. University of Washington Press, Seattle.

ZACHARIAH, K., and P. C. FITZ-JAMES. 1967. The structure of phialides in *Penicillium claviforme*. Can. J. Microbiol. 13: 249-256.

ZUCK, R. K. 1946. Isolates intermediate between *Stachybotrys* and *Memnoniella*. Mycologia 38: 69-76.

BOOK REVIEWS *(continued from page 396)*

STUDIES ON HIGHER FUNGI, A COLLECTION OF PAPERS DEDICATED TO DR. ALEXANDER H. SMITH ON THE OCCASION OF HIS SEVENTIETH BIRTHDAY, par Howard E. BIGELOW et Harry D. THIERS, éditeurs, 372 p., 12 figs., 78 pl. bl.-n. & coul. Beihefte zur Nova Hedwigia 51, 1975, ed. J. Cramer, FL-9490 Vaduz, Liechtenstein. DM 250.-

En l'honneur de Alexander H. Smith, les auteurs ne pouvaient mieux offrir que cet imposant ensemble de 26 contributions sur la taxonomie des Basidiomycètes venant de ses disciples mycologues et parmi les plus réputés et d'une sur les Ascomycètes (*Helvella* par Nancy Smith Weber), précédé du récit vivant des souvenirs mycologiques de Madame Helen V. Smith.

Parmi les travaux taxonomiques, on retiendra d'abord les revisions de genres ou de parties de genres, notamment de *Russula* subsect. *Emeticinae* (R. L. Shaffer), *Cortinarius* sect. *Dermocybe* (J. F. Ammirati & M. S. Gilliam), *Cortinarius* subgen. *Telamonia* (K. H. McKnight), *Hygrophoropsis, Cantharellula, Myxomphalia* et *Omphaliaster* (H. E. Bigelow), *Panellus* et *Dictyopanus* (H. H. Burdsall, Jr. & O. K. Miller, Jr.), *Suillus* (H. D. Thiers) et *Alpova* et *Rhizopogon* (J. M. Trappe). De nouvelles espèces sont aussi décrites dans ces genres et les suivants, *Campanella, Melanomphalia, Pleurotus, Amanita, Naematoloma, Cantharellus, Boletopsis* et *Tomentella*.

On ne peut oublier les études plus spéculatives, mais non moins intéressantes, sur les affinités entre les Agaricales et les Gastéromycètes, *Amanita* et *Torrendia* (C. Bas) ou *Smithiogaster* n.g. (J. E. Wright), ou entre genres ou espèces dans les Gastéromycètes (L. E. Hawker; J. M. Trappe), dans les Bolbitiaceae (R. Watling), dans *Pluteus* R. L. Homola) ou dans *Suillus* (H. D. Thiers). Mentionnons aussi les observations ultrastructurales sur deux Bolets (H. Clemençon) à verser au dossier de la future 'ultracytotaxonomie.'

ON MUCOR MUCEDO, MUCOR FLAVUS AND RELATED SPECIES, par M. A. A. SCHIPPER, 33 p.; 7 figs. Studies in Mycology, No. 10, Sept. 1975. Centraalbureau voor Schimmelcultures, Baarn, Pays-Bas. Hfl. 10.-

Dans le but de revoir la spéciation des *Mucor* sur la base de l'interfertilité des souches et la variation morphologique de l'appareil sporangial, l'auteur explore cette fois les espèces des sections *Mucor* et *Flavus* de Zycha. L'interfertilité des souches types permet d'établir la synonymie de *Mucor albo-ater* avec *M. piriformis*, et de *M. peacockensis* et *M. attenuatus* avec *M. mucedo*.

Parmi les autres espèces acceptées, *Mucor saturninus, M. plasmaticus* et *M. flavus* ont produit des zygospores, tandis que *M. aligarensis, psychrophilus, strictus* et *minutus* restent sporangiales.

(continued on page 552)

MYCOTAXON

Vol. III, No. 3, pp. 487-551 April-June 1976

FUNGI THAT DECAY MESQUITE IN SOUTHERN ARIZONA[1]

R. L. GILBERTSON

Department of Plant Pathology
University of Arizona, Tucson 85721

H. H. BURDSALL, Jr.

Center for Forest Mycology Research
Forest Products Laboratory, Forest Service
U.S. Department of Agriculture, Madison, Wisconsin 53705

E. R. CANFIELD[2]

College of Forestry, Wildlife, and Range Sciences
University of Idaho, Moscow, Idaho 83843

SUMMARY

Forty-eight species of lignicolous Basidiomycetes are reported from mesquite in Arizona. *Phellinus badius* and *Inonotus texanus* are the main causes of heartrot in living mesquite. Three new species, *Hypochnicium prosopidis*, *Mycoacia austro-occidentale*, and *Poria baboquivariensis* are described.

Common mesquite (*Prosopis juliflora* (Sw.) DC.) is a woody member of the Leguminosae with a wide distribution in the Southwest. It occurs most frequently as a spreading shrub on drier sites but also becomes a tree with a trunk 1 to 4 feet in diameter and up to 50 feet in height along streams. Benson (1941) considers the species to be composed of 3 intergrading varieties; var. *glandulosa*, var.

---

[1] University of Arizona Agricultural Experiment Station Journal article No. 2594

[2] Formerly, Visiting Assistant Professor, Department of Plant Pathology, University of Arizona.

torreyana, and var. *velutina*. We have made no effort to distinguish between these varieties as hosts of the wood decay fungi discussed below. Screwbean mesquite (*P. pubescens* Benth.) occurs in some localities in southeastern Arizona but we have not investigated the fungi on this species.

In southern Arizona common mesquite is distributed from the fringe of the Sonoran Desert to the adjoining desert-grasslands, and upward to the lower portion of the oak-woodland zone. At lower elevations it is associated with other woody legumes such as catclaw acacia (*Acacia greggii* Gray), whitethorn acacia (*A. constricta* Benth.), yellow palo verde (*Cercidium microphyllum* (Torr.) Rose and Johnston), and blue palo verde (*C. floridum* Benth.). Other associates include several species of prickly pear and cholla cacti (genus *Opuntia*), the giant saguaro cactus (*Carnegiea gigantea* (Engelm.) Britt. et Rose) and creosote bush (*Larrea tridentata* (DC.) Coville). Along stream beds it is associated to some extent with a great diversity of hardwood trees. Among these are Fremont cottonwood (*Populus fremontii* S. Wats.), Arizona walnut (*Juglans major* (Torr.) Heller), velvet ash (*Fraxinus velutina* Torr.), desert willow (*Chilopsis linearis* (Cav.) Sweet), Arizona sycamore (*Platanus wrightii* S. Wats.), Goodding willow (*Salix gooddingii* Ball), and others. At its highest elevational range it is an infrequent associate of Emory oak (*Quercus emoryi* Torr.) in the lower portion of the oak-woodland zone.

Decay of heartwood in living mesquite is due mainly to two fungi, *Phellinus badius* and *Inonotus texanus*, both of which cause a white rot. Their mode of entrance into the heartwood is unknown. Tunnels of the mesquite borer (*Megacyllene antennatus* (White)) are a possible infection court. Both *P. badius* and *I. texanus* are restricted in their American distribution to the arid Southwest. *Inonotus texanus* is not known to occur elsewhere, but *P. badius* is widely distributed throughout the tropical regions of the world.

Dead branches of mesquite might seem an unlikely place for the development of wood-rotting fungi. However, a very distinctive group of species has adapted to this dry environment and is generally found wherever mesquite grows. The four most important branch decay fungi are *Peniophora tamaricicola*, *Byssomerulius corium*, *Peniophora albobadia*, and *Exidiopsis leucophaea*. Other species frequently found fruiting on dead branches are *Peniophora nuda*, *Phanerochaete tuberculata*, *Phanerochaete arizonica*, and *Phanerochaete allantospora*. All of these fungi produce basidiocarps that remain dry and dormant over long periods of little or no precipitation and low humidity. Following precipitation during the summer and winter rainy periods, they revive and begin sporulation very quickly. Basidiocarps of all of the branch decay fungi mentioned above (except for *Exidiopsis leucophaea*, a Heterobasidiomycete) have a typical euhymenium and have no specialized structures that enable them to remain viable over dry, hot periods. It is of interest that no species of *Aleurodiscus* or *Laeticorticium* are found on branches of mesquite although members of these genera are found on dead branches of trees at higher elevations in the Southwest and in more northern latitudes. Apparently the catahymenium and thick-walled resting probasidia found in many species of these genera are not adapted to survival over long periods in a hot, dry climate.

A number of other fungi have been found on dead fallen branches, dead standing trees, and fallen mesquite. *Phellinus ferruginosus*, *Poria tarda*, and *Antrodia heteromorpha* are probably the most important decay fungi on dead, fallen mesquite wood.

Our observations indicate that the fungi treated here are all associated with white rots except *Antrodia heteromorpha*, *Panus fulvidus* and *Coniophora eremophila*.

In the descriptions that follow, capitalized color names are from Ridgway (1912). The collectors cited by initials are R. L. Gilbertson (RLG), E. R. Canfield (ERC), and H. H. Burdsall, Jr. (HHB). A few collections by others are cited, and in these cases the collector's name is given.

Research by Gilbertson and Canfield was supported by McIntire-Stennis project No. 2016-4166-23 in the University of Arizona Agricultural Experiment Station.

CHECKLIST OF FUNGI THAT DECAY MESQUITE IN SOUTHERN ARIZONA

TREMELLALES

1. *Dacrymyces minor* Pk.
2. *Exidiopsis calcea* (Pers.) Wells
3. *Exidiopsis leucophaea* (Bres.) Wells
4. *Platygloea mycophila* Burds. et Gilbertson
5. *Platygloea peniophorae* Bourd. et Galz.
6. *Tremella simplex* Jacks. et Martin

APHYLLOPHORALES

Coniophoraceae

7. *Coniophora eremophila* Lindsey et Gilbertson

Corticiaceae

8. *Athelia coprophila* (Wakef.) Jülich
9. *Byssomerulius corium* (Fr.) Parm.
10. *Byssomerulius sulphureus* (Burt) Lindsey
11. *Hyphoderma amoenum* (Burt) Donk
12. *Hyphoderma* sp. (RLG 10255)
13. *Hyphodontia quercina* (Fr.) J. Erikss.
14. *Hyphodontia sambuci* (Pers. ex Fr.) J. Erikss.
15. *Hypochnicium bombycinum* (Sommerf. ex Fr.) J. Erikss.
16. *Hypochnicium prosopidis* Burds.
17. *Mycoacia austro-occidentale* Canf.
18. *Odontia pruni* Lasch
19. *Peniophora albobadia* (Schw. ex Fr.) Boidin
20. *Peniophora nuda* (Fr.) Bres.
21. *Peniophora tamaricicola* Boidin et Malençon
22. *Phanerochaete allantospora* Burds. et Gilbertson
23. *Phanerochaete arizonica* Burds. et Gilbertson
24. *Phanerochaete chrysorhizon* (Torr.) Budington et Gilbertson
25. *Phanerochaete tuberculata* (Karst.) Parm.
26. *Phlebia ochraceofulva* (Bourd. et Galz.) Donk

Cyphellaceae

27. *Henningsomyces candidus* (Pers.) O. Kuntze

Ganodermataceae

28. *Ganoderma lucidum* (Leyss. ex Fr.) Karst.

Hymenochaetaceae

29. *Hymenochaete arida* Karst.
30. *Hymenochaete rubiginosa* Dicks. et Lev.
31. *Inonotus texanus* Murr.
32. *Phellinus badius* (Berk.) G. H. Cunn.
33. *Phellinus ferruginosus* (Schrad. ex Fr.) Bourd. et Galz.
34. *Phellinus gilvus* (Schw.) Pat.

Lachnocladiaceae

35. *Vararia tropica* Welden

Polyporaceae

36. *Antrodia heteromorpha* (Fr.) Donk
37. *Polyporus arcularius* Batsch ex Fr.
38. *Poria apacheriensis* Gilbertson et Canf.
39. *Poria baboquivariensis* Gilbertson
40. *Poria latemarginata* (Dur. et Mont.) Cke.
41. *Poria medulla-panis* (Jacq. sensu Pers.) Bres.
42. *Poria subincarnata* (Pk.) Murr.
43. *Poria tarda* (Berk.) Cke.
44. *Funalia gallica* (Fr.) Bond. et Sing.

Stereaceae

45. *Lopharia crassa* (Lév.) Boidin

Thelephoraceae

46. *Tomentella coerulea* (Bres.) Hoehn. et Litsch.

AGARICALES

47. *Marasmius siccus* (Schw.) Fr.
48. *Panus fulvidus* Bres.

KEY TO WOOD-ROTTING BASIDIOMYCETES ON MESQUITE IN ARIZONA

1. Basidia septate or bifurcate 2
1. Basidia not septate or bifurcate, of the homobasidium type. 7
    2. Basidia bifurcate. . . . . 1. *Dacrymyces minor*
    2. Basidia septate. 3

3. Basidia transversely septate. 4
3. Basidia vertically septate 5
4. Basidia with one septum; basidiospores spherical . . . . 4. *Platygloea mycophila*
4. Basidia with three septa; basidiospores ellipsoid . . . . .5. *Platygloea peniophorae*
5. Basidiocarps gelatinous; parasitic on other fungi; basidia one- or two-celled. . . 6. *Tremella simplex*
5. Basidiocarps not gelatinous; not parasitic on other fungi; basidia four-celled at maturity. . 6
6. Basidiocarps discoid, with a hirsute, inrolled margin; hymenial surface purplish-gray. . . . . 3. *Exidiopsis leucophaea*
6. Basidiocarps broadly effused, chalky white . . . . 2. *Exidiopsis calcea*
7. Hymenium lining the inner surface of united tubes 8
7. Hymenium not lining the inner surface of united tubes 21
8. Upper surface of pileus crustlike, often appearing varnished; basidiospores truncate, with a pitted exospore. . .28. *Ganoderma lucidum*
8. Upper surface neither crustlike nor appearing varnished or basidiocarps not pileate; basidiospores not as above. 9
9. Basidiocarp tissue brown, permanently blackening in KOH solution 10
9. Basidiocarp tissue white to pale colored, not permanently blackening in KOH solution. 13
10. Setae abundant in the hymenium; basidiospores hyaline 11
10. Setae not present in the hymenium; basidiospores pigmented 12
11. Basidiocarps resupinate; setae large, up to 65 um long; basidiospores oblong. . . . . 33. *Phellinus ferruginosus*
11. Basidiocarps pileate; setae small, up to 30 um long; basidiospores ovoid . . . . 34. *Phellinus gilvus*
12. Basidiocarps annual; upper surface cracking concentrically and radially into rectangular scales. . . . . 31. *Inonotus texanus*
12. Basidiocarps perennial; upper surface becoming blackened and rimose. . . . 32. *Phellinus badius*

13. Basidiocarps stipitate, sessile, effused-reflexed, or occasionally resupinate; basidiospores large, cyclindric, over 7 µm long 14
13. Basidiocarps always resupinate; basidiospores subglobose to ellipsoid, or if cylindric, not over 5 µm long 16
    14. Basidiocarps stipitate .37. *Polyporus arcularius*
    14. Basidiocarps not stipitate 15
15. Basidiocarps small; pores 1-3 per mm; upper surface tomentose to glabrous; associated with a brown cubical rot . . . . 36. *Antrodia heteromorpha*
15. Basidiocarps becoming much larger; pores commonly over 1 mm diam; upper surface hispid; associated with a uniform white rot. . . . . 44. *Funalia gallica*
    16. Generative hyphae with simple septa. . . . 17
    16. Generative hypae with clamp connections. . 18
17. Pore surface pink on fresh specimens; basidiospores short-cylindric. . . . . 43. *Poria tarda*
17. Pore surface white to cream-colored; basidiospores broadly ellipsoid to ovoid.. . . . . 40. *Poria latemarginata*
    18. Hyphal system monomitic, only nodose-septate generative hyphae present 19
    18. Hyphal system dimitic, with thick-walled skeletal or binding hyphae 20
19. Basidiocarps orange; basidiospores minutely echinulate. . . . . .39. *Poria baboquivariensis*
19. Basidiocarps white to cream-colored; basidiospores smooth . . . . 39. *Poria apacheriensis*
    20. Basidiospores ovoid, often truncate, dextrinoid in Melzer's reagent . . . . 41. *Poria medulla-panis*
    20. Basidiospores allantoid, negative in Melzer's reagent . . . . .42. *Poria subincarnata*
21. Hymenium lining inner surface of individual, white, tubular basidiocarps. . . 27. *Henningsomyces candidus*
21. Hymenium not lining individual tubes. 22
    22. Basidiocarps stipitate; hymenophore in form of radial gills 23
    22. Basidiocarps resupinate or effused-reflexed; hymenophore not as above 24
23. Basidiocarps fragile, with dark brown filamentous stipe and reddish-brown cap; basidiospores 13-16 x 4-5 µm. . . . . .47. *Marasmius siccus*
23. Basidiocarps not fragile, cap and stipe pale tan to cream-colored; basidiospores 12-15 x 6-6.5 µm. . . . . .48. *Panus fulvidus*

24. Basidiocarp tissue becoming permanently black in KOH; setae present in hymenium. 25

24. Basidiocarp tissue not becoming black in KOH; setae not present in hymenium. 26

25. Basidiospores cylindric; hyphae loosely arranged. . . . . 29. *Hymenochaete arida*

25. Basidiospores ovoid; hyphae compactly arranged. . . . . 30. *Hymenochaete rubiginosa*

26. Basidiospores pale brown 27

26. Basidiospores hyaline. 28

27. Basidiospores echinulate, negative in Melzer's reagent . . . . 46. *Tomentella coerulea*

27. Basidiospores smooth, dextrinoid in Melzer's reagent . . . . .7. *Coniophora eremophila*

28. Hymenial surface merulioid, with irregular shallow folds and ridges 29

28. Hymenial surface smooth, tuberculate, or distinctly hydnaceous 30

29. Basidiocarps resupinate to effused-reflexed; upper surface grayish, tomentose; hymenial surface tan to reddish-purple . . . . . . 9. *Byssomerulius corium*

29. Basidiocarps resupinate, with abundant rhizomorphs; hymenial surface bright yellow. . . . . .10. *Byssomerulius sulphureus*

30. Hymenial surface distinctly hydnaceous . . 31

30. Hymenial surface smooth or tuberculate . . 34

31. Basidiocarps bright orange-yellow; rhizomorphs present . . . . .24. *Phanerochaete chrysorhizon*

31. Basidiocarps white to cream-colored or pale buff; rhizomorphs not present 32

32. Hyphae with simple septa only, clamp connections not present. . . . 18. *Odontia pruni*

32. Hyphae with abundant clamp connections . . 33

33. Hymenial surface with smooth, well-developed cylindric teeth; heavily incrusted hyphae imbedded in inner tissue of teeth; hymenial cystidia absent . . . 17. *Mycoacia austro-occidentale*

33. Hymenial surface with short, fimbriate teeth; cystidia present, cylindric or capitate. . . . . .13. *Hyphodontia quercina*

34. Dichohyphidia abundant in hymenial region and subiculum. . . . . 35. *Vararia tropica*

34. Dichohyphidia not present. 35

35. Hyphae with simple septa only, clamp connections lacking 36

35. Hyphae with abundant clamp connections. 39

36. Cystidia not present in the hymenium . . . . . 25. *Phanerochaete tuberculata*

36. Cystidia present in the hymenium 37

37. Hymenial surface purple when fresh, drying brown; cystidia thick-walled, heavily incrusted . . . . 45. *Lopharia crassa*

37. Hymenial surface cream-colored to pale buff; cystidia thin-walled, not incrusted 38

38. Basidiospores allantoid, 10-11.5 x 2.5-3 µm . . . . .22. *Phanerochaete allantospora*

38. Basidiospores cylindric, 6.5-7 x 2-2.5 µm . . . . 23. *Phanerochaete arizonica*

39. Heavily incrusted cystidia imbedded in subiculum and in hymenium; imbedded or projecting gloeocystidia also present. 40

39. Cystidia if present, not heavily incrusted; gloeocystidia absent. 42

40. Basidiocarps resupinate or effused-reflexed; hymenial surface dark purplish-brown with whitish margin . . . . .19. *Peniophora albobadia*

40. Basidiocarps always resupinate; hymenial surface pale purplish-gray or pink when fresh; margin concolorous 41

41. Basidiocarps pink when fresh, becoming cinereous and extensively cracked into small rectangular blocks on drying; dendrohyphidia present . . . . 21. *Peniophora tamaricicola*

41. Basidiocarps pale purplish-gray when fresh and on drying; dendrohyphidia not present . . . . 20. *Peniophora nuda*

42. Cystidia not present 43

42. Cystidia present 44

43. Basidiocarps fleshy, crustlike on drying; basidiospores broadly ellipsoid, 7-10 x 5-6.5 µm. . . . . 15. *Hypochnicium bombycinum*

43. Basidiocarps arachnoid, fragile; basidiospores subglobose, 5-6 x 4-4.5 µm. . . 8. *Athelia coprophila*

44. Cystidia of two types, some acicular and others capitate. . . . . 14. *Hyphodontia sambuci*

44. Cystidia of one type 45

45. Cystidia acicular, thin-walled, 4-5 um diam and projecting to 30 µm . . . . 26. *Phlebia ochraceofulva*

45. Cystidia clavate or moniliform, thin- to thick-walled, up to 10 µm diam and projecting to 70 µm or over. 46

46. Basidiospores broadly ellipsoid, up to 8.5 µm wide. . . . . 16. *Hypochnicium prosopidis*
46. Basidiospores narrowly ellipsoid, up to 6 µm wide. 47
47. Basidiospores cylindric-ellipsoid, 11-13 x 5.5-6 µm. . . . . .11. *Hyphoderma amoenum*
47. Basidiospores broadly ellipsoid to ovoid, 5-6.5 x 4-4.5 µm. . . .12. *Hyphoderma* sp. (RLG 10255)

1. DACRYMYCES MINOR Pk., Ann. Rept. N.Y. State Mus. 30:49. 1877.

Basidiocarps discoid to slightly cerebriform, gelatinous, pale orange-yellow to olivaceous yellow, up to 1 mm diam, attached by a central point; hyphae imbedded in a gelatinous matrix, thin-walled, 2-4 µm diam, simple-septate; basidia (Fig. 1a) bifurcate, up to 70 µm long; basidiospores (Fig. 1b) broadly allantoid, 12-13 x 5-6 µm, becoming 1-3 septate, hyaline, negative in Melzer's reagent.

Dacrymyces minor is found on dead branches of a number of desert trees and shrubs. The associated rot has not been determined. Some of the basidiocarps of *D. minor* in ERC 71-48 were found parasitized by *Platygloea peniophorae* and *Tremella simplex*, described as collections ERC 71-48a and 71-48b, respectively in this paper.

Voucher specimens: ERC 71-48 and HHB 5945, Santa Rita Expt. Range, Santa Rita Mts., Pima County; HHB 5954, Redington Rd., east of Tucson, Pima County.

2. EXIDIOPSIS CALCEA (Pers.) Wells, Mycologia 53:348. 1961.

Sebacina calcea (Pers.) Bres., Fungi Trid. 2:64. 1892.

Basidiocarps broadly effused, thin, hard and crust-like, at first small spots, then coalescing to form patches to 1-1.5 x 15-20 cm, cracking extensively to expose the substrate; hymenial surface white to grayish-white, smooth, shiny; margin minutely fimbriate, sometimes abrupt; hyphae of two kinds, one narrow, branched and sinuous, 1-1.5 µm diam, aseptate, the other branched, 3-5 µm diam, with clamp connections, these giving rise to basidia; basidia (Fig. 2a, 2b) with a basal clamp, subglobose to ellipsoid, becoming longitudinally septate, 4-celled at maturity, 12-15 x 15-25 µm, epibasidia up to 35 µm long; basidiospores (Fig. 2c) broadly allantoid, 16-20 x 6-8 µm, smooth, hyaline, negative in Melzer's reagent.

Exidiopsis calcea occurs on dead branches of a number of trees and shrubs from the desert to the coniferous forest zones. It is associated with a white rot.

Voucher specimens: RLG 10538, 10541, ERC 71-359, San Pedro River at Camp Grant Wash, Pinal County.

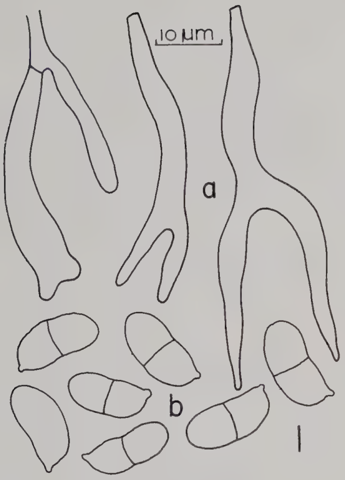
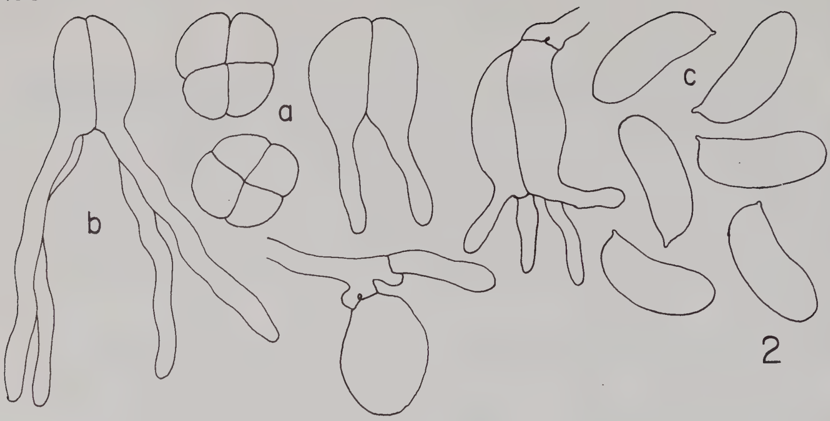


Fig. 1. *Dacrymyces minor* (ERC 71-48). a, basidia; b, basidiospores.

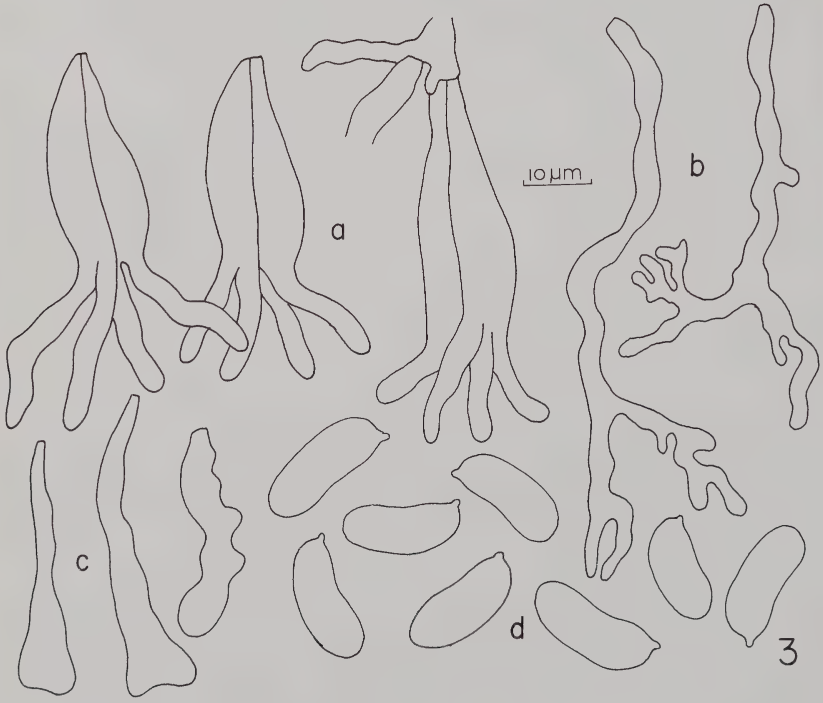
3. EXIDIOPSIS LEUCOPHAEA (Bres.) Wells, Mycologia 53: 352. 1961.

Basidiocarps disciform, cupulate, 1-6 mm diam, single to densely gregarious and crowded; margins free, densely tomentose-hirsute with matted white hairs; hymenial surface smooth, Light Grayish-Vinaceous or Light Vinaceous Fawn (grayish-pink), margin paler; hyphae of abhymenial surface hyaline, thin-to thick-walled, unbranched, aseptate, 2-4 um diam, with very slight wall thickening, somewhat refractive, difficult to separate, clamp connections present but obscure; subhymenial hyphae gelatinized and difficult to separate; dendrohyphidia (Fig. 3b, 3c) almost cylindric or lobed, up to 8 µm diam, others profusely branched, 2.5-3.5 µm diam; basidia (Fig. 3a) ellipsoid, longitudinally septate, 20-30 x 13-15 µm, with obscure basal clamps, usually proliferating through the clamp, with 4 stout epibasidia, these 3.5-5 µm diam, up to 30 µm long; basidiospores (Fig. 3d) cylindric to broadly allantoid, 15-20 x 6-7.5 µm, smooth, hyaline, negative in Melzer's reagent, prominently apiculate.

Exidiopsis leucophaea is common on dead branches of



2



3

Fig. 2. *Exidiopsis calcea* (ERC 71-131). a, basidia in various stages of development; b, mature basidium; c, basidiospores. Fig. 3. *Exidiopsis leucophaea* (ERC 71-47). a, basidia; b, dendrohyphidia; c, unbranched hyphidia; d, basidiospores.

mesquite and has been found on a number of other Sonoran Desert trees and shrubs. It is associated with a white rot.

Voucher specimens: RLG 10215, ERC 71-47, ERC 71-135, Santa Rita Expt. Range, Santa Rita Mts., Pima County; RLG 10497, near Kitt Peak Junction, Papago Indian Reservation, Santa Cruz County; RLG 10550, San Pedro River near Camp Grant Wash, Pinal County.

4. PLATYGLOEA MYCOPHILA Burds. et Gilbertson, Mycologia 66:702-706. 1974.

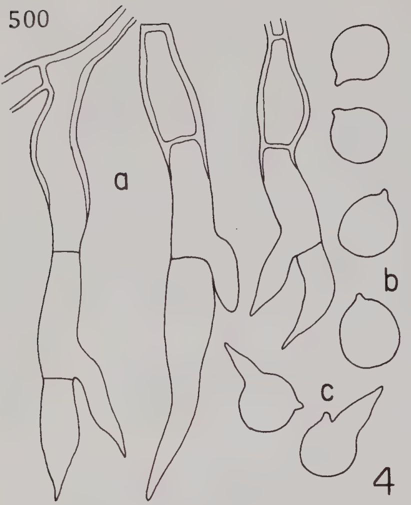
Basidiocarps circular, appressed pustules, up to 2 mm diam, on *Peniophora tamaricicola* Boidin et Malenc., immature areas and margin white and pubescent when dry, mature areas yellowish-brown and smooth when dry; subicular hyphae 4-7 µm diam, in hymenium of *Peniophora tamaricicola*, simple septate, regularly branched, with walls up to 2 µm thick, slightly refractive; basidia (Fig. 4a) arising directly from subicular hyphae, oval to cylindrical, 10-25 x 6-9 µm, with slightly thickened walls, septate at base; metabasidium cut off from probasidium by basal septum, 24-40 x 5-7 µm, cylindrical, protruding from among elements of the *Peniophora* hymenium, 1-septate, 2-sterigmate, sterigmata 10-25 x 5-7 µm; basidiospores (Fig. 4b) 7-9 µm diam, globose to subglobose, thin-walled, hyaline, smooth, negative in Melzer's reagent, with large apiculus, germination by repetition (Fig. 4c).

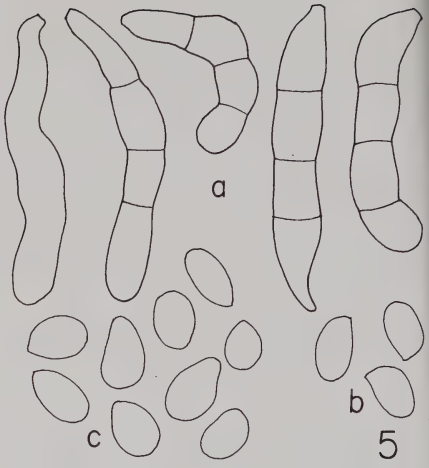
Platygloea mycophila is known only as a parasite on *Peniophora tamaricicola* on dead branches of mesquite and desert broom (*Baccharis sarothroides* Gray).

Voucher specimens: HHB 5948a, HHB 5953a, Redington Rd. Rd., Rincon Mts., Pima County; RLG 10577, Peck Canyon, Tumacacori Mts., Santa Cruz County.

5. PLATYGLOEA PENIOPHORAE Bourd. et Galz., Bul. Soc. Mycol. France 25:17. 1909.

Parasitizing *Dacrymyces minor* and not producing a basidiocarp distinct from that of the host; hyphae embedded in hymenium of host, 1-2 µm diam, with clamps; basidia (Fig. 5a) straight or curved, 30-50 x 6-9 µm, becoming 3-septate, sterigmata filiform, up to 75 µm long; basidiospores (Fig. 5b) cylindric-ellipsoid, hyaline, 8-9 x 4-4.5





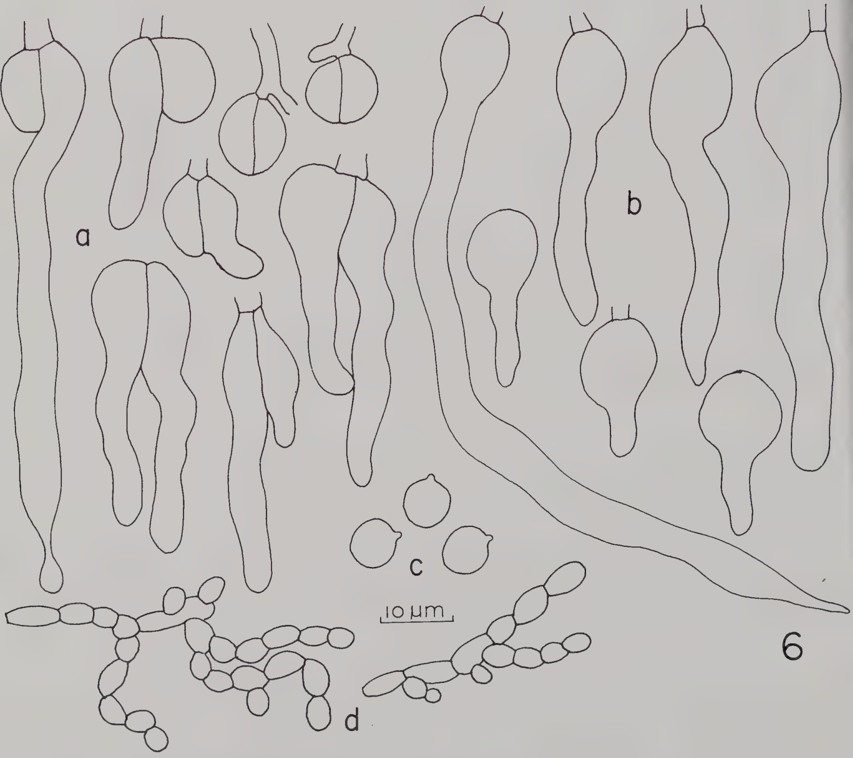


Fig. 4. *Platygloea mycophila* (RLG 10056). a, basidia; b, basidiospores; c, germinating basidiospores. Fig. 5. *Platygloea peniophorae* (ERC 71-48A). a, basidia; b, basidiospores, c, conidia. Fig. 6. *Tremella simplex* (ERC 71-48B). a, two-celled basidia; b, one-celled basidia; c, basidiospores; d, conidia.

µm, negative in Melzer's reagent; hymenial conidia (Fig. 5c) abundant, variable in shape, some attenuated at one end, others ellipsoid to subglobose, thick walled, hyaline, negative in Melzer's reagent, 7-12 x 5-7 µm.

Voucher specimens: ERC 71-48a, parasitizing *Dacrymyces minor* on mesquite branches, Santa Rita Exp. Range, Santa Rita Mts., Pima County.

6. TREMELLA SIMPLEX Jacks. et Martin, Mycologia 32:687. 1940.

Basidiocarps gelatinous, discoid or pulvinate, less than 1 mm diam, very inconspicuous and difficult to distinguish from the host basidiocarps (*Dacrymyces minor*); hyphae septate, lacking clamps; conidial branches abundant, moniliform, conidia subglobose to ellipsoid, 3-5 µm long; basidia globose, 9-16 µm diam, some becoming 2-celled (Fig. 6a) with a single vertical septum and producing 1 or 2 epibasidia, others remaining one-celled (Fig. 6b), producing a single epibasidium; epibasidia 3-6 µm diam, up to 100 µm long; basidiospores (Fig. 6c) 6-7 µm diam, globose, with a prominent apiculus, hyaline, negative in Melzer's reagent; conidia (Fig. 6d) catenulate, ellipsoid, 2.5-6 x 2-3 µm.

Tremella simplex and *Platygloea peniophorae* were found on basidiocarps of *Dacrymyces minor* in the same collection on mesquite branches.

Voucher specimen: ERC 71-48B, Santa Rita Expt. Range, Santa Rita Mts., Pima County.

7. CONIOPHORA EREMOPHILA Lindsey et Gilbertson, Mycotaxon 2:86. 1975.

Basidiocarps fragile, easily separated, becoming widely effused; hymenial surface smooth, colored Light Brownish Olive by the massed basidiospores; hymenial tissue soft and floccose over a white, arachnoid lower subiculum; margin with fine white mycelial strands from subiculum; subicular hyphae (Fig. 7a) simple-septate or with very rare clamps (Fig. 7c), hyaline, thin-walled, mostly 2-6 µm diam but with some cells inflated up to 10 µm (Fig. 7b), some lightly incrusted; basidia (Fig. 7d) clavate, usually sinuous, often with a basal swelling, 4-sterigmate, 50-55

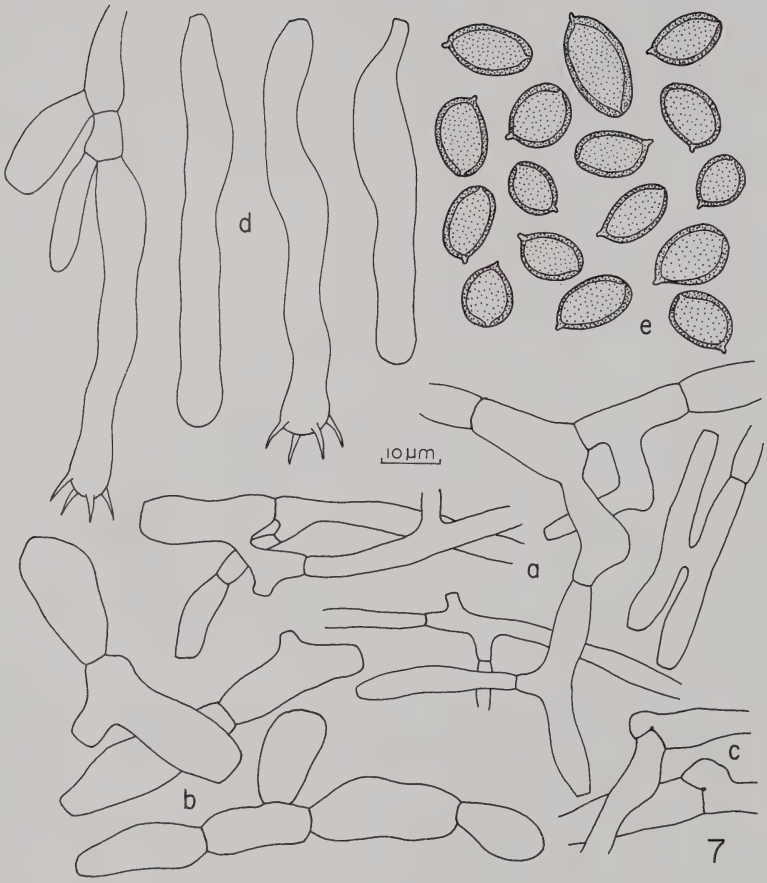


Fig. 7. *Coniophora eremophila* (RLG 10925). a, uniform subicular hyphae; b, closely septate, swollen subicular hyphae; c, nodose-septate subicular hyphae; d, basidia; e, basidiospores.

x 6-8 µm, with a basal septum, sterigmata up to 7 µm long; basidiospores (Fig. 7e) brownish-olive in mass, pale yellow in KOH, dextrinoid in Melzer's reagent, thick-walled, oval to broadly cylindric, with a prominent peg-like apiculus and apical germ pore, 7.5-14 x 5-9 µm.

Coniophora eremophila occurs on other Sonoran Desert

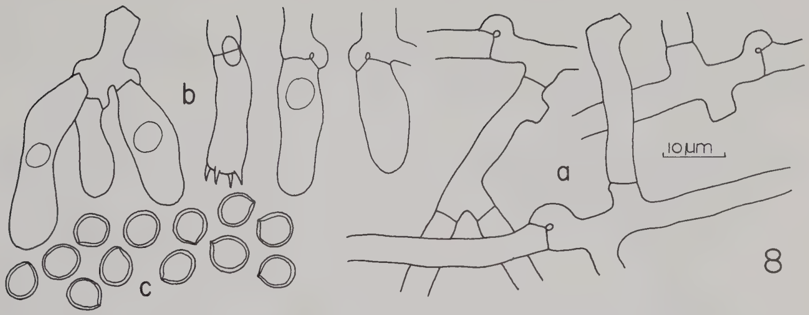


Fig. 8. *Athelia coprophila* (RLG 10926). a, subicular hyphae; b, basidia; c, basidiospores.

plants, including *Carnegiea gigantea* (Engelm.) Britt. et Rose (saguaro), *Olneya tesota* Gray (ironwood), and *Sambucus mexicana* Presl (Mexican elder), and is associated with a brown rot.

Voucher specimen: RLG 10925, Canyon del Oro, Santa Catalina Mts., Pinal County (TYPE).

8. ATHELIA COPROPHILA (Wakef.) Jülich, Willdenowia 7:66. 1972.

Corticium coprophilum Wakef., Trans. Brit. Mycol. Soc. 6:480. 1916.

Basidiocarps becoming widely effused, thin, soft, tomentose, easily separated; hymenial surface grayish-white, smooth to slightly tuberculate, under 30X lens appearing interrupted with arachnoid subiculum and mycelial strands visible below hymenium; hyphal system monomitic; subicular hyphae (Fig. 8a) thin-walled, with simple septa and occasional clamps, 3-5 µm diam; clamps abundant in subhymenial hyphae; basidia (Fig. 8b) cylindric to clavate, 4-sterigmate, 19-30 x 5-7 µm, with a basal clamp; basidiospores (Fig. 8c) subglobose, 5-6 x 4-4.5 µm, hyaline, smooth, thick-walled, negative in Melzer's reagent.

Athelia coprophila is associated with a white rot of fallen mesquite.

Voucher specimens: RLG 10387, Aravaipa Canyon, Galliuro Mts., Pinal County; RLG 10926, Canyon del Oro, Santa Catalina Mts., Pinal County (ARIZ).

9. BYSSOMERULIUS CORIUM (Fr.) Parm., Akad. Sci. Estonian SSR, Biol. Sci. 16:383. 1967.

Merulius corium Fr., Elenchus Fung. 1:58. 1828.

Basidiocarps effused to narrowly reflexed; upper surface white, tomentose; hymenial surface waxy, reticulately poroid, pale buff to dark cinnamon-brown or reddish-purple; subicular hyphae (Fig. 9a) 3-5 μm diam, simple-septate, with thin to slightly thickened walls, distinct near the substratum, often gelatinizing and agglutinated in the subhymenial layer; cystidia none; basidia (Fig. 9b) narrowly clavate, 40-50 x 6-7 μm, 4-sterigmate, with a basal septum; basidiospores (Fig. 9c) cylindric to cylindric-ellipsoid, 6-8.5 x 3-4.5 μm, hyaline, smooth, negative in Melzer's reagent.

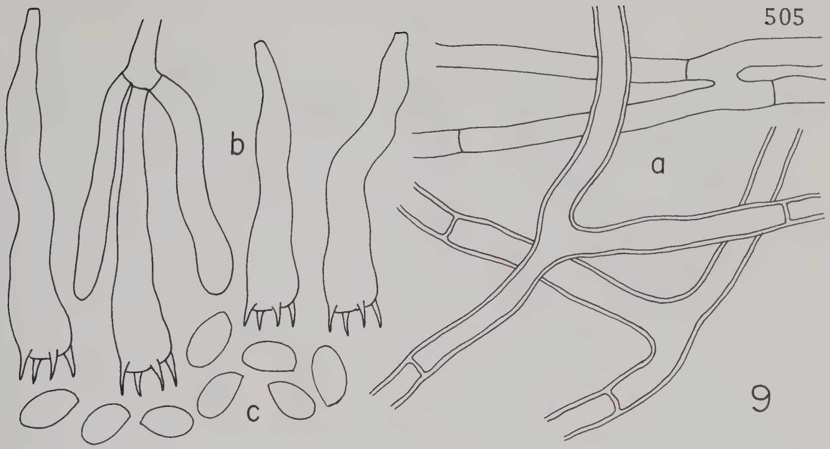
Byssomerulius corium causes a white rot of dead branches. This is one of the most important branch decay fungi on mesquite, and is generally conspicuous wherever mesquite is found.

Voucher specimens: RLG 7761, Patagonia-Lochiel Rd., Patagonia Mts., Santa Cruz County; RLG 9311, Buenos Aires, Baboquivari Mts., Santa Cruz County; ERC 71-54, Santa Rita Exp. Range, Santa Rita Mts., Pima County.

10. BYSSOMERULIUS SULPHUREUS (Burt) Lindsey, Univ. Ariz. Agr. Expt. Sta. Tech. Bul. 209, p. 5. 1973.

Merulius sulphureus Burt, Ann. Missouri Bot. Gard. 4: 333. 1917.

Basidiocarps effused up to 5 cm, soft, fragile, easily separated from the substrate, associated with abundant yellow mycelium and slender white to yellow rhizomorphic strands in the litter under the wood; hymenial surface shallowly merulioid, bright lemon-yellow when fresh, (Barium Yellow to Pale Lemon Yellow), cracking on drying to expose the white arachnoid subiculum; hyphal system monomitic; subicular hyphae (Fig. 10a) 3-4.5 μm diam, simple-



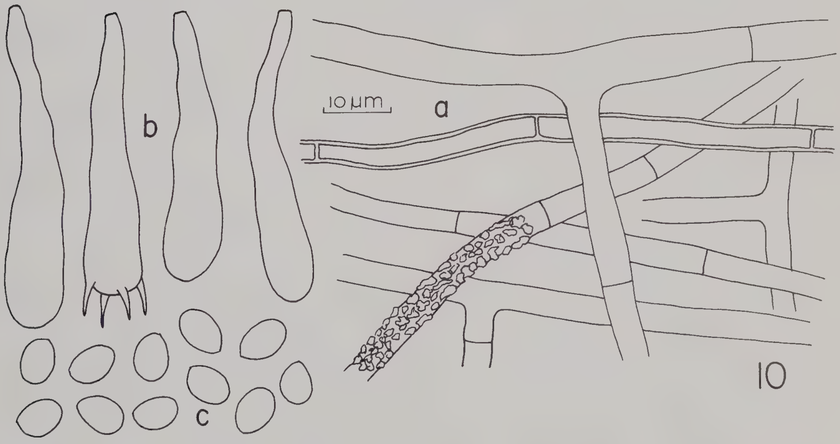


Fig. 9. *Byssomerulius corium* (RLG 7761). a, subicular hyphae; b, basidia; c, basidiospores. Fig. 10. *Byssomerulius sulphureus* (RLG 10499). a, subicular hyphae; b, basidia; c, basidiospores.

septate, with occasional branching, thin-walled; cystidia none; hyphidia in hymenial layer slender, contorted, some lobed or sparsely branched, 40-60 x 2-4 μm; basidia (Fig. 10b) narrowly clavate, with a basal septum, 35-40 x 6-7 μm, 4-sterigmate; basidiospores (Fig. 10c) ellipsoid, 6-8 x 4-5 μm, hyaline, smooth, negative in Melzer's reagent.

Byssomerulius sulphureus was originally described from

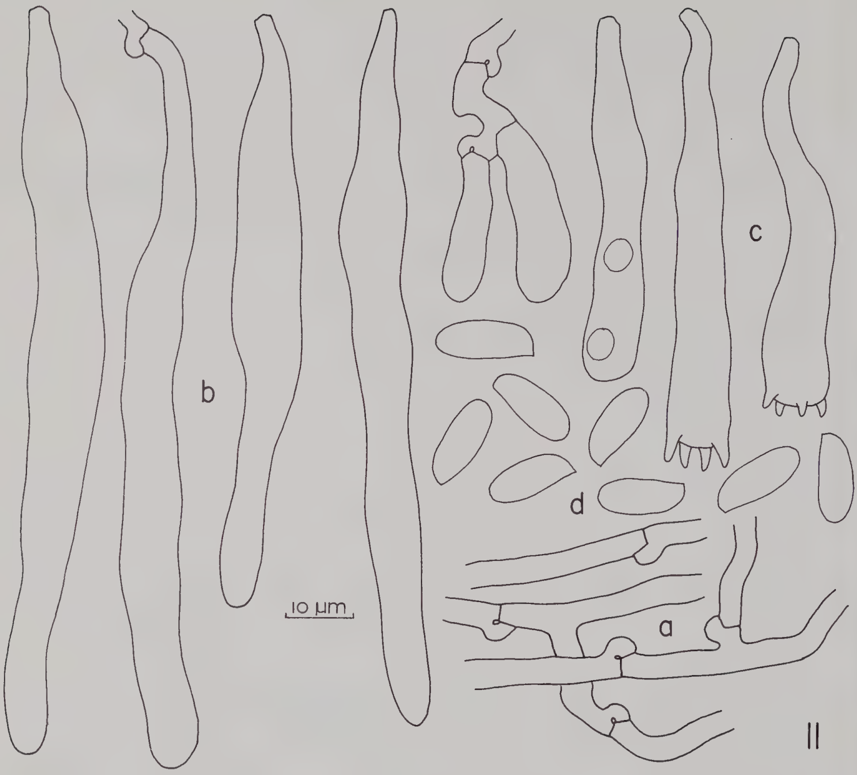


Fig. 11. *Hyphoderma amoenum* (ERC 71-21). a, subicular hyphae; b, cystidia; c, basidia; d, basidiospores.

Florida and is apparently known elsewhere only from Arizona. It has also been found on ironwood (Gilbertson, et al., 1974) and is associated with a white rot.

Voucher specimens: RLG 10498, Rest Area near Kitt Peak Rd., Ariz. Rt. 86, Pima County; HHB 5852, and 5856, Santa Rita Exp. Range, Santa Rita Mts., Pima County; RLG 10929, Canyon del Oro, Santa Catalina Mts., Pinal County.

11. HYPHODERMA AMOENUM (Burt) Donk, Fungus 27:14. 1957.

Peniophora amoena Burt, Ann. Missouri Bot. Gard. 12: 276. 1925.

Basidiocarps effused up to 2 cm, adnate; hymenial surface smooth, Pale Pinkish Buff to Cartridge Buff, finely tomentose, cracking on drying to reveal white subiculum; margin white, tomentose; hyphal system monomitic; subicular hyphae (Fig. 11a) hyaline, thin-walled, with clamps, 2.5-4 µm diam, lightly incrusted with hyaline crystals; cystidia (Fig. 11b) frequent, cylindric, 65-100 x 5-8 µm, with a basal clamp, tapered slightly to the apex, some with constrictions, projecting to 70 µm; basidia (Fig. 11c) clavate, 4-sterigmate, 38-44 x 7.5-9 µm, with a basal clamp, sterigmata up to 7 µm long and 2 µm wide at the base; basidiospores (Fig. 11d) cylindric, 9-13 x 5-6 µm, hyaline, smooth, thin-walled, negative in Melzer's reagent.

Hyphoderma amoenum is associated with a white rot of dead branches of a number of Sonoran Desert trees and shrubs.

Voucher specimen: KJM 331, Canyon del Oro, Santa Catalina Mts., Pinal County.

12. HYPHODERMA sp. (RLG 10255).

Basidiocarps effused up to 5 cm, waxy, adnate, cracking on drying; hymenial surface pale buff, slightly tuberculate, cystidiate under a 30X lens; hyphal system monomitic; subicular hyphae (Fig. 12a) thin-walled, with clamps, 3-5 µm diam, some (Fig. 12b) irregularly contorted; cystidia (Fig. 12c) frequent, cylindric to narrowly clavate, with uniformly slightly thickened walls, 80-130 x 4-10 µm, with a basal clamp; basidia (Fig. 12d) clavate, 4-sterigmate, 35-40 x 6-7 µm, with a basal clamp; basidiospores (Fig. 12e) broadly ellipsoid to ovoid, 5-6.5 x 4-4.5 µm, hyaline, smooth, negative in Melzer's reagent.

Hyphoderma sp. (RLG 10255) is associated with a white rot of dead, fallen mesquite. The small basidiospores and large cystidia are a combination of characters not found in any species of *Hyphoderma* known to us. The single small specimen is not an adequate basis for describing a new taxon although the microscopic structures are well developed and distinctive.

Voucher specimen: RLG 10255, Redington, San Pedro Valley, Pima County.

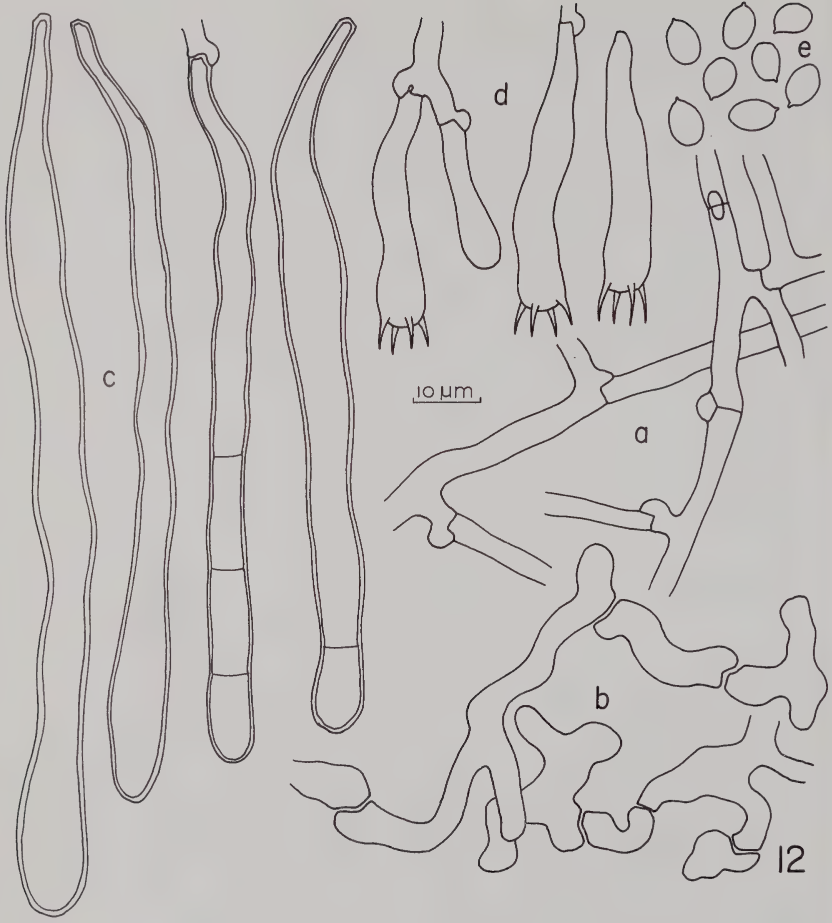
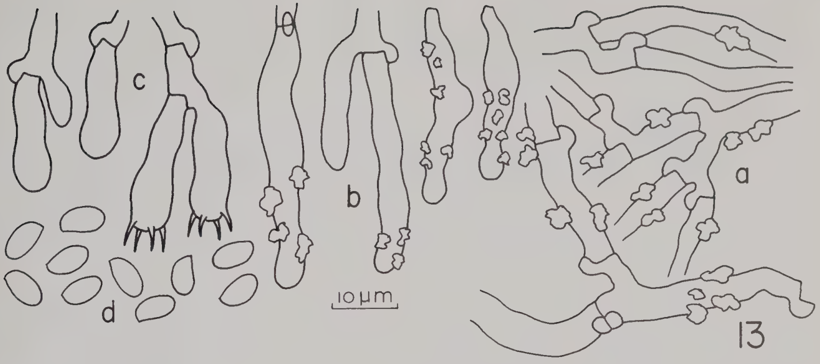


Fig. 12. *Hyphoderma* sp. (RLG 10255). a, uniform subicular hyphae; b, contorted subicular hyphae; c, cystidia d, basidia; e, basidiospores.

13. HYPHODONTIA QUERCINA (Fr.), J. Erikss., Symb. Bot. Upsalienses XVI: 1, p. 105, 1958.

Radulum quercinum Fr., Hym. Eur., p. 623. 1874.

Basidiocarps effused up to 8 cm, adnate, cracking to expose white byssoid subiculum; hymenial surface white to Cream Color, with crowded short teeth that appear fimbriate



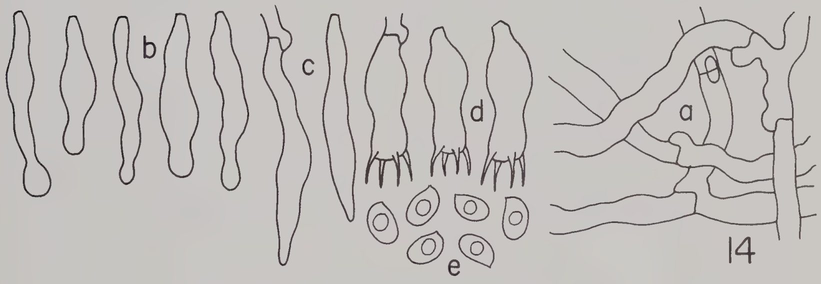


Fig. 13. *Hyphodontia quercina* (RLG 10042). a, subicular hyphae; b, cystidia; c, basidia; d, basidiospores. Fig. 14. *Hyphodontia sambuci* (ERC 71-61). a, subicular hyphae; b, capitate cystidia; c, acicular cystidia; d, basidiospores.

at apices under 30X lens; margin thinning out; subiculum very thin, white, soft; hyphal system monomitic; subicular hyphae (Fig. 13a) 2.5-4 µm diam, with abundant clamps, with frequent branching, loosely interwoven, moderately thick-walled; cystidia (Fig. 13b) abundant in hymenial layer, irregularly cylindric or slightly swollen at the apex, 3-5 µm diam, projecting up to 10 µm, smooth or lightly incrusted with coarse crystals; basidia (Fig. 13c) clavate with median constriction, 17-20 x 4.5-5.5 µm, 4-sterigmate; basidiospores (Fig. 13d) cylindric-oblong, 6-7.5 x 2.5-3 µm, hyaline, smooth, negative in Melzer's reagent.

Hyphodontia quercina is associated with a white rot of dead, decorticated branches on standing plants.

Voucher specimen: RLG 10042, Patagonia-Lochiel Rd., Patagonia Mts., Santa Cruz County.

14. HYPHODONTIA SAMBUCI (Pers. ex Fr.) J. Erikss., Symb. Bot. Upsalienses XVI:1, p. 104. 1958.

Peniophora sambuci (Pers. ex Fr.) Burt, Ann. Missouri Bot. Gard. 12:233. 1926.

Basidiocarps broadly effused, soft, adnate; hymenial surface smooth, pellicular, minutely farinose under 30X lens; subiculum white, byssoid; hyphal system monomitic; subicular hyphae (Fig. 14a) 2-4 µm diam, thin-walled, with abundant clamps, with occasional branching, with abundant crystalline material; cystidia frequent, acicular (Fig. 14c) or with swollen apices (Fig. 14b), 3-4 µm diam, thin-walled, projecting slightly, not incrusted; basidia (Fig. 14d) clavate, with median constriction, 15-20 x 6-7 µm, 4-sterigmate; basidiospores (Fig. 14e) cylindric-ellipsoid to broadly ellipsoid, smooth, hyaline, negative in Melzer's reagent, 6-7 x 3.5-4.5 µm.

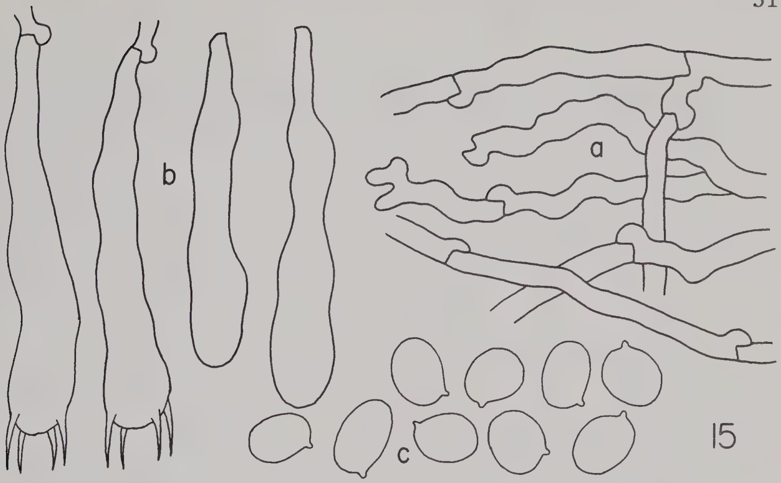
Hyphodontia sambuci is associated with a white rot of dead branches.

Voucher specimen: ERC 179, Patagonia - Lochiel Rd., Patagonia Mts., Santa Cruz County.

15. HYPOCHNICIUM BOMBYCINUM (Sommerf. ex Fr.) J. Erikss., Symb. Bot. Upsalienses XVI:1, p. 101. 1958.

Corticium bombycinum (Sommerf. ex Fr.) Karst., Hedwigia 32: 120. 1893.

Basidiocarps becoming broadly effused, adnate; hymenial surface smooth to slightly tuberculate or raduloid, Cream Color to Light Buff or watery grayish-white before drying; margin arachnoid to fibrillose; hyphal system monomitic; subicular hyphae (Fig. 15a) hyaline, thin- to slightly thick-walled, with clamps, 2-4.5 µm diam; cystidia none; basidia (Fig. 15b) clavate, 4-sterigmate, 50-60 x 9-11 µm, with a basal clamp; basidiospores (Fig. 15c) broadly ellipsoid, 7-10 x 5-6.5 µm, smooth, hyaline, negative in Melzer's reagent, with slightly thickened walls.



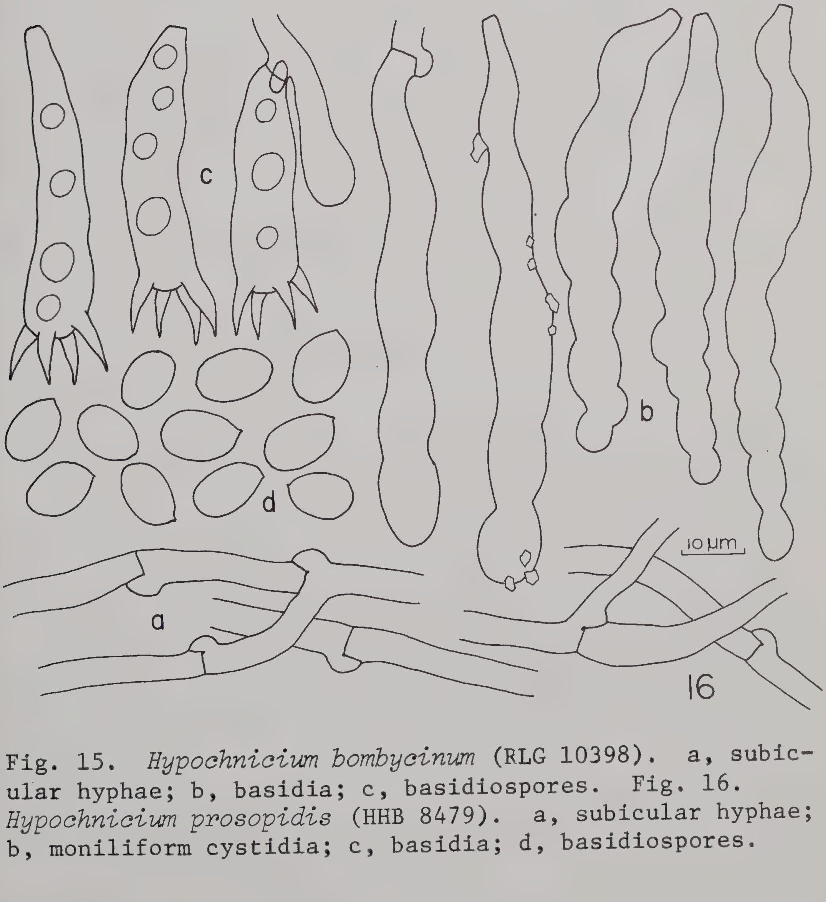


Fig. 15. *Hypochnicium bombycinum* (RLG 10398). a, subicular hyphae; b, basidia; c, basidiospores. Fig. 16. *Hypochnicium prosopidis* (HHB 8479). a, subicular hyphae; b, moniliform cystidia; c, basidia; d, basidiospores.

Hypochnicium bombycinum is associated with a white rot of dead hardwoods and conifers and is found occasionally on dead mesquite branches.

Voucher specimens: RLG 10394 and 10398, Aravaipa Canyon, Nature Conservancy Reserve, Galliuro Mts., Pinal County.

16. HYPOCHNICIUM PROSOPIDIS Burdsall, sp. nov.

Basidiocarpus effusus, mollis; hymenium laevis vel tuberculatus, cremea vel roseo-cremea; margo albus, arachnoideus; hyphis systematis monomitica; hyphae 2.5-4 µm diam, fibulatae, tenuitunicatae; cystidia inclusa, moniliformae, 60-85 x 5-10 µm; basidia late-clavata, 40-45 x 8-11 µm, 4-sterigmatibus; basidiosporae late-ellipsoidae, 9-12 x 5.5-8.5 µm, hyalinae, laeves, non-amyloidae. HOLOTYPUS: in ligno *Prosopis juliflora* (Sw.) DC., Santa Rita Mts., Pima County, Arizona, U.S.A., leg. H. H. Burdsall, Jr., No. 8479; in herb. CFMR; isotypus in herb. ARIZ.

ETYMOLOGY: from *Prosopis* (generic name for mesquite), the only substrate on which *H. prosopidis* is known.

Basidiocarps effused up to 6 cm, up to 0.2 mm thick, adnate, soft, crumbling on sectioning when dry; hymenial surface smooth to slightly tuberculate, finely tomentose under 30X lens, Cartridge Buff to Pinkish Buff, cracking deeply on drying; margin white, arachnoid to farinaceous; subiculum thin, concolorous with hymenial surface; hyphal system monomitic; subicular hyphae (Fig. 16a) hyaline, thin-walled, with abundant clamps and frequent branching, 2.5-4 µm diam, lightly incrusted with hyaline crystals; cystidia (Fig. 16b) arising at various levels in subiculum, completely imbedded or projecting slightly from hymenium, thin-walled, nearly cylindrical, moniliform, with few or several constrictions, 60-85 x 5-10 µm, with a basal clamp, some lightly incrusted with large crystals, negative in sulfuric benzaldehyde; basidia (Fig. 16c) broadly clavate, 4-sterigmate, 40-45 x 8-11 µm, with a basal clamp, sterigmata up to 2 µm diam at base and up to 8 µm long; basidiospores broadly ellipsoid, 9-12 x 5.5-8.5 µm, smooth, hyaline, with slightly thickened walls, negative in Melzer's reagent.

Hypochnicium prosopidis is morphologically similar to *H. bombycinum* but differs in having moniliform cystidia. Cystidia of other species of *Hypochnicium* (*H. analogum*, *H. geogenium*, *H. punctulatum*, and *H. sphaerosporum*) are not moniliform. Basidiospores of *H. analogum* and *H. punctulatum* are globose to subglobose with tuberculate walls. Those of *H. sphaerosporum* are also globose but are smooth. *Hypochnicium geogenium* basidiospores are much smaller (6.5-8 x 4.5-5 µm) than those of *H. prosopidis*.

Hypochnicium prosopidis is associated with a white rot of fallen mesquite branches.

Voucher specimen: Holotype previously mentioned.

17. MYCOACIA AUSTRO-OCCIDENTALE Canfield, sp. nov.

Fructificatio annua, resupinata, hydnacea, cremea vel pallido-bubalina; aculei cylindrici, 1-3 mm longi; margo cremea, tenua, fimbriata; hyphae fibulatae, 2.5-3.5 µm diam, aliquae incrustatae; cystidia nulla; basidia clavata, 4-sterigmatibus, 20-21 x 5-6 µm; basidiosporae ellipsoidae, 4-4.5 x 2-2.5 µm, tunica hyalina, levi, non-amyloidea. HOLOTYPUS: in ligno *Prosopis juliflora* (Sw.) DC., Arizona Highway 86, prope Kitt Peak Rd., Pima County, Arizona, leg. R. L. Gilbertson No. 10501, in herb. CFMR.

ETYMOLOGY: from Southwest, referring to the southwestern United States.

Basidiocarps adnate, effused; hymenial surface strongly hydnaceous, pale buff to cream, teeth cylindric, simple or confluent, smooth, apices entire or minutely fimbriate, up to 3 mm long; margin thinning out, cream-colored, minutely fimbriate; hyphal system monomitic; subicular hyphae (Fig. 17a) with abundant clamps, thin-walled, with occasional branching, 2.5-3.5 µm diam; cystidia none; some heavily incrusted hyphae imbedded in inner tissue of teeth, these not projecting from hymenial layer; basidia (Fig. 17b) clavate, 20-21 x 5-6 µm, 4-sterigmate; basidiospores (Fig. 17c) ellipsoid, 4-4.5 x 2-2.5 µm hyaline, smooth, negative in Melzer's reagent.

Mycoacia austro-occidentale is associated with a white rot of fallen mesquite trunks.

Voucher specimen: holotype previously mentioned.

18. ODONTIA PRUNI Lasch, in Rabenhorst, Fungi. Europ. Exsiccati No. 1514. 1872.

Basidiocarps becoming broadly effused, adnate; hymenial surface Pale Ochraceous Buff to Cinnamon-Buff, hydnaceous, the teeth minute, finely fimbriate at apex; margin thinning out; hyphal system monomitic; subicular hyphae (Fig. 18a) simple-septate, thin-walled, 2-5 µm diam, fascicles of heavily incrusted hyphae (Fig. 18b) present in inner tissue of teeth and extending to the apex, some entirely imbedded, others projecting, the entire fascicle up to 30 µm diam; cystidia none; narrow, sinuous or lobed hymenial elements (Fig. 18c) present, barely projecting, 2-3 µm diam; basidia (Fig. 18d) clavate, 4-sterigmate, 35-45 x 6-7 µm, with a basal septum; basidiospores (Fig. 18e) ellipsoid, 7-8 x 4-5 µm, hyaline, smooth, negative in Melzer's reagent.

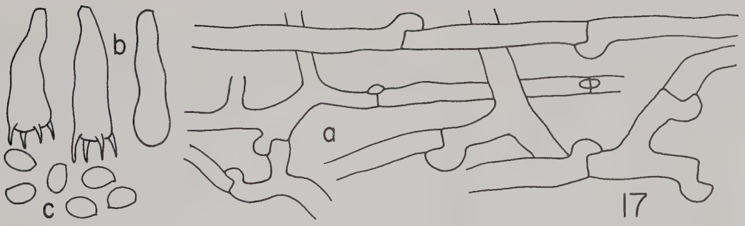
Odontia pruni is associated with a white rot of dead hardwoods over a wide elevational range in the Southwest. Jülich (1974) transferred *O. pruni* to the genus *Hyphoderma*. The lack of clamps casts doubt on this relationship and we prefer to retain the older name for the present.

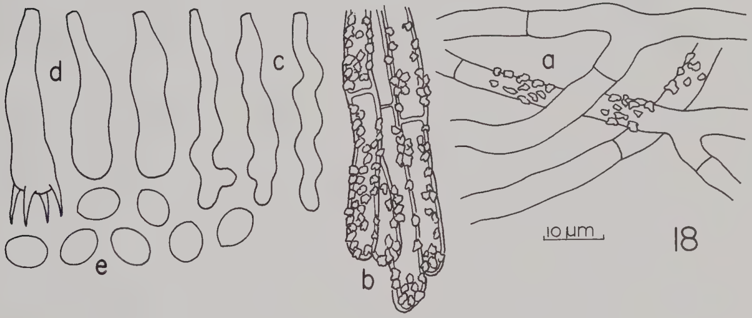
Voucher specimen: HHB 5971-A, Redington, San Pedro Valley, Pima County.

19. PENIOPHORA ALBOBADIA (Schw. ex Fr.) Boidin, Rev. Mycol. 26:164. 1961.

Stereum albobadium (Schw. ex Fr.) Fr., Epicr. Syst. Mycol., p. 551. 1838.

Basidiocarps thin, usually effused, 1 to 3 mm at first, enlarging and coalescing to 15-20 x 2-5 cm, occasionally reflexed, upper surface of reflexed portions brown, silky to strigose; hymenial surface dark brown with areas of purplish-brown (Drab) to cinnamon brown, fading to vinaceous-brown or gray-brown (Drab Gray); margin pale buff to white, tomentose to velutinous; hyphal system dimitic; generative hyphae (Fig. 19a) hyaline to pale brownish in KOH, with clamps, 3-5 µm diam; skeletal hyphae (Fig. 19b) thick-walled, brownish in KOH, aseptate, with frequent





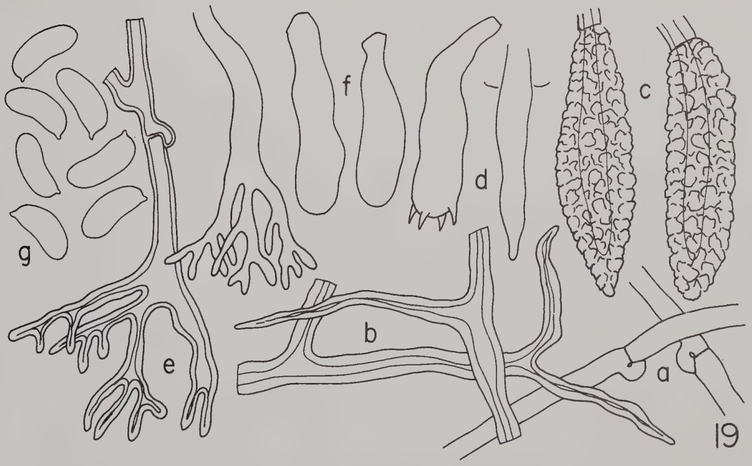


Fig. 17. *Mycoacia austro-occidentale* (RLG 10501). a, subcular hyphae; b, basidia; c, basidiospores. Fig. 18. *Odontia pruni* (HHB 5971A). a, subicular hyphae; b, fascicle of incrusted hyphae; c, sinuous or lobed hymenial elements; d, basidia; e, basidiospores. Fig. 19. *Peniophora albobadia* (ERC 87). a, generative hyphae; b, dendritic skeletal hyphae; c, incrusted cystidia; d, thin-walled, fusoid cystidium; e, dendrohyphidia; f, basidia; g, basidiospores.

branching, narrowing down to very slender tips; dendrohyphidia (Fig. 19e) abundant in hymenium, branched apices pale yellow-brown in KOH; cystidia (Fig. 19c) hyaline, conical, incrusted, imbedded or projecting up to 20 µm, 12-15 x 25-30 µm; basidiospores (Fig. 19g) broadly cylindric and slightly curved, 10.5-13 x 3.5-5 µm, smooth, hyaline, negative in Melzer's reagent.

Peniophora albobadia is associated with a white rot of dead branches and fallen wood of a number of hardwood trees and shrubs in the Southwest.

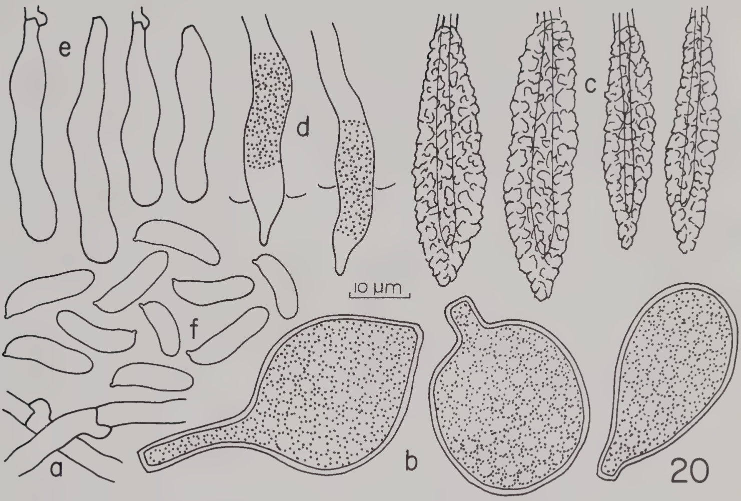
Voucher specimens: ERC 87, Patagonia, Santa Cruz County; ERC 177, Box Canyon, 10 miles east of Florence, Pinal County; RLG 10543, Camp Grant Wash, San Pedro River Valley, Pinal County.

20. PENIOPHORA NUDA (Fr.) Bres., Atti I. R. Accad. Sci. Lett. Art. Agiati, ser. 3, 3:114. 1897.

Basidiocarps becoming broadly effused, thin, crustaceous, at first in small patches, then coalescing to cover areas up to 1 x 4 cm, hymenial surface smooth, light gray to pale pinkish gray; margin abrupt; hyphal system monomitic; subicular hyphae (Fig. 20a) 2-3.5 µm diam, hyaline, with frequent branching, thin-walled or with slight wall thickening, with clamps; gloeocystidia (Fig. 20b) imbedded in subiculum or occasionally in hymenium, pyriform to subglobose, 40-50 x 15-25 µm, hyaline, thick-walled, with a basal clamp, with granular to globular contents, becoming light blue to dark blue in sulfuric benzaldehyde; cystidia (Fig. 20c,d) scattered in hymenium, subulate, 25-35 x 5-6 µm, thin-walled, some heavily incrusted with hyaline crystals, protruding 10 µm beyond basidia; basidia (Fig. 20e) narrowly clavate, slightly sinuous, 30-40 x 5-6 µm, hyaline, thin-walled, 4-sterigmate, some regenerating by percurrent proliferation, occasionally with transverse septa; basidiospores (Fig. 20f) cylindric to allantoid, 13-15 x 3-3.5 µm, hyaline, thin-walled, smooth, negative in Melzer's reagent.

Peniophora nuda is associated with a white rot of dead branches on many hardwood species.

Voucher specimen: RLG 8442, Sonoita Creek, near Patagonia, Santa Cruz County.



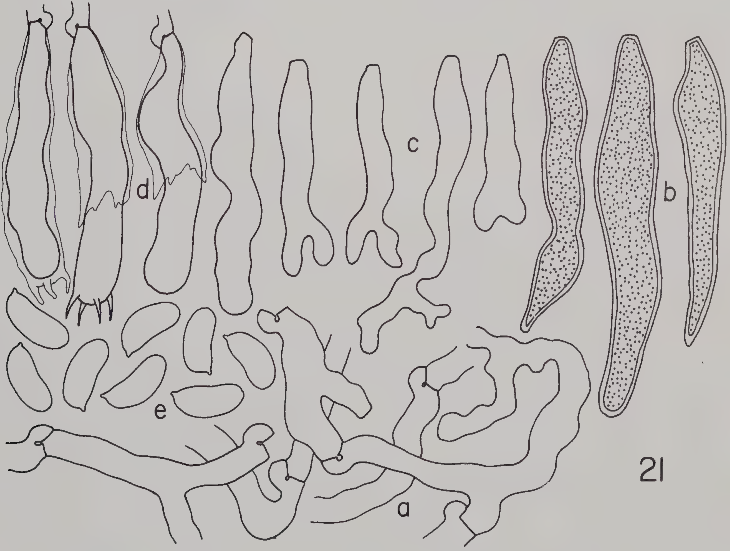


Fig. 20. *Peniophora nuda* (RLG 8442). a, subicular hyphae; b, gloeocystidia; c, incrusted cystidia; d, thin-walled, fusoid cystidia; e, basidia; f, basidiospores. Fig. 21. *Peniophora tamaricicola* (RLG 10496). a, subicular hyphae; b, gloeocystidia; c, dendrohyphidia; d, basidia; e, basidiospores.

21. PENIOPHORA TAMARICICOLA Boidin et Malençon, Rev. Mycol. 26:153. 1961.

Basidiocarps becoming broadly effused, adnate, drying tough and horny, cracking extensively on drying into small angular blocks; hymenial surface smooth to distinctly tuberculate, pruinose, pink when fresh, pale purplish-gray on dried specimens (Pale Smoke Gray, Pallid Mouse Gray or Light Gull Gray); margin abrupt and fertile; subiculum pale brown, hymenial layer distinct and white in longitudinal sections; hyphal system monomitic, subicular hyphae (Fig. 21a) agglutinated and difficult to separate, thin- to thick-walled, all with inconspicuous clamps, 3-4 µm diam; gloeocystidia swollen, vesicular, imbedded in subiculum, some with refractive granular contents, strongly positive in sulfuric benzaldehyde; hymenial gloeocystidia (Fig. 21b) occasional, barely projecting, acuminate, some with refractive contents, weakly to distinctly positive in sulfuric benzaldehyde; dendrohyphidia (Fig. 21c) lightly incrusted, sparsely branched, 2-3 µm diam; basidia (Fig. 21d) clavate, developing by percurrent proliferation, 25-40(-50) x 7-7.5 µm, 4-sterigmate; basidiospores (Fig. 21e) smooth, cylindric to allantoid, 10.5-11.5 x 4-4.5 µm, hyaline, negative in Melzer's reagent.

Peniophora tamaricicola was recently reported from North America as a major decay fungus on dead branches of mesquite as well as a number of other desert shrubs in southern Arizona (Gilbertson and Burdsall, 1975). It is associated with a white rot.

Voucher specimens: HHB 6223, Guadalupe Canyon, Peloncillo Mts., Cochise County; RLG 10055, Santa Rita Expt. Range, Santa Rita Mts., Pima County; RLG 10577, Peck Canyon Rd., Tumacacori Mts., Santa Cruz County; ERC 71-271, Peppersauce Canyon, Santa Catalina Mts., Pima County; RLG 10388, Aravaipa Canyon, Galliuro Mts., Pinal County.

22. PHANEROCHAETE ALLANTOSPORA Burds. et Gilbertson, Mycologia 66:780. 1974.

Basidiocarps effused in small confluent crustaceous patches, adnate; hymenial surface Pale Yellow-Orange to Light Buff, smooth to slightly tuberculate, cracking on drying to expose white subiculum; margin thinning out, white, narrow, sterile; subiculum white, soft; hyphal system monomitic; subicular hyphae (Fig. 22a) loosely arranged, septate, lacking clamps, with frequent branching, 2-4.5 µm diam, walls slightly thickened, smooth, or incrusted with pale yellow granules; cystidia (Fig. 22b) infrequent, cylindric, tapering to the apex, smooth, thin-walled, hyaline, 50-125 x 5.5-8 µm and projecting to 15 µm, pale yellowish-brown granules on imbedded portion; basidia (Fig. 22c,d) clavate, hyaline, thin-walled, 22-27 x 6-6.5 µm, 4-sterigmate, with a basal septum; basidiospores (Fig. 22e) allantoid, 10-11.5 x 2.5-3 µm, hyaline, smooth, thin-walled, negative in Melzer's reagent.

Phanerochaete allantospora is associated with a white rot of dead branches on several desert trees and shrubs in Arizona.

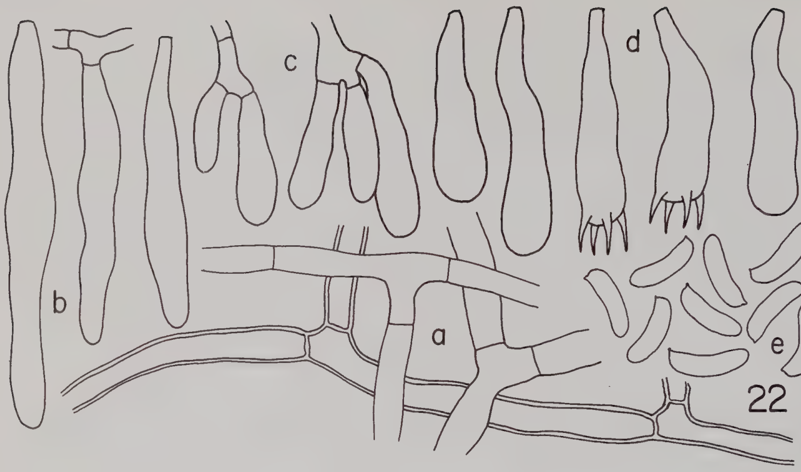
Voucher specimens: ERC 69, Cottonwood Springs, Sonoita Creek, Santa Cruz County; ERC 71-258, Nature Conservancy Area, Aravaipa Canyon, Pinal County; RLG 10540, 10542, Camp Grant Wash, San Pedro River Valley, Pinal County.

23. PHANEROCHAETE ARIZONICA Burds. et Gilbertson, Mycologia 66:785. 1974.

Basidiocarps effused up to 8 cm, adnate; hymenial surface becoming raduloid with scattered rounded projections, cream-colored to pale buff (Light Buff), minutely cystidiate under 30X lens, cracking on drying to expose a white, arachnoid subiculum below; margin white, thin, fibrillose; hyphal system monomitic; subicular hyphae (Fig. 23a) hyaline, septate, lacking clamps at most septa, thin- to thick-walled, heavily incrusted with hyaline crystals, with frequent branching, 3-7 µm diam; cystidia (Fig. 23b) nearly cylindric, tapering to apex, 50-80 x 4-6 µm, thin-walled, with a basal septum; basidia (Fig. 23c) clavate, 4-sterigmate, 25-30 x 5-7 µm, with a basal septum; basidiospores (Fig. 23d) cylindric, hyaline, thin-walled, negative in Melzer's reagent, smooth, 5-7 x 2.5-3 µm.

Phanerochaete arizonica is associated with a white rot of dead branches and fallen stems of several desert trees and shrubs.

Voucher specimen: RLG 10393, Guadelupe Canyon,



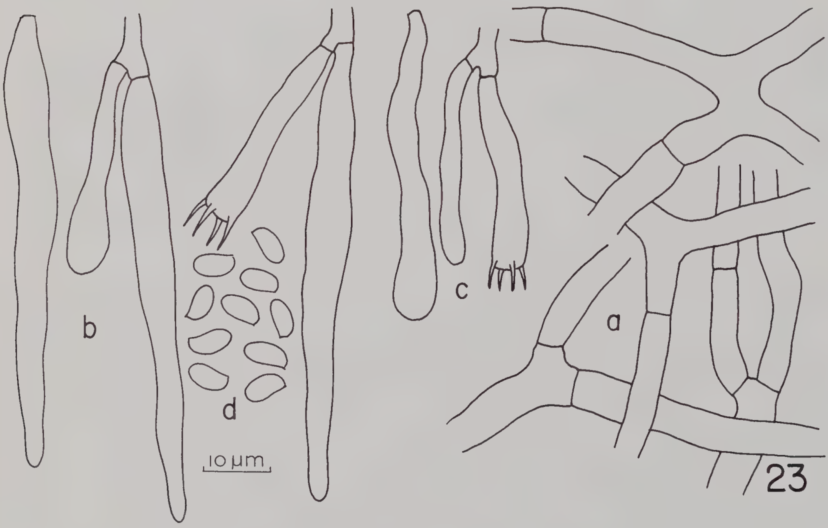


Fig. 22. *Phanerochaete allantospora* (ERC 69). a, subicular hyphae; b, cystidia; c, immature basidia; d, mature basidia; e, basidiospores. Fig. 23. *Phanerochaete arizonica* (RLG 10383). a, subicular hyphae; b, cystidia; c, basidia; d, basidiospores.

Peloncillo Mts., Cochise County.

24. PHANEROCHAETE CHRYSORHIZON (Torr.) Gilbertson et Budington, Southwestern Nat. 17(4):417. 1973.

Hydnum chrysorhizon Torr., in Eaton, Manual of Botany, ed. 3, p. 309. 1822.

Basidiocarps effused in small patches, fragile, pelliculose, easily separated from the substratum; hymenial surface bright orange-yellow to cream-colored, becoming strongly hydnaceous, teeth cylindric, up to 1 mm long; margin rhizomorphic with orange-yellow to white, plumose fans of radiating hyphal strands in arachnoid mycelium; yellow to cream rhizomorphs usually present on substratum and in adjacent soil and litter; hyphal system monomitic; subicular hyphae with abundant septa (Fig. 24a) and occasional single or double clamp connections (Fig. 24b,c), smooth or lightly incrusted, 4-8 µm diam; cystidia (Fig. 24d) few, cylindric, 35-40 x 4-4.5 µm, thin-walled, projecting to 25 µm; basidia (Fig. 24e) clavate, 4-sterigmate, with a basal septum, 20-30 x 5.5-7 µm; basidiospores (Fig. 24f) oblong, 5-6 x 4-4.5 µm, hyaline, smooth, negative in Melzer's reagent.

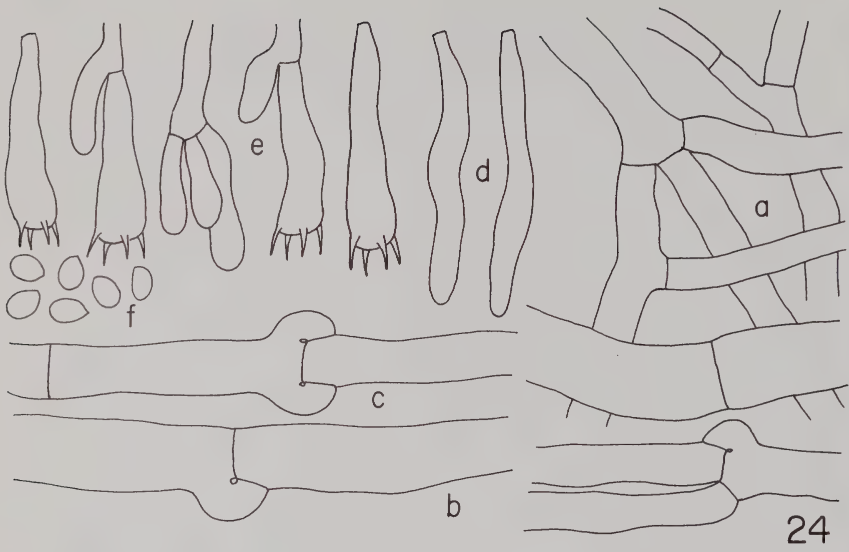
Phanerochaete chrysorhizon is associated with a white rot of fallen hardwoods and is also common on dead cotton roots in Arizona.

Voucher specimens: RLG 10507, Sycamore Canyon, Baboquivari Mts., Papago Indian Res., Santa Cruz County; RLG 10391, Aravaipa Canyon, Galliuro Mts., Pinal County; RLG 10887 and 10888, Pima Canyon, Santa Catalina Mts., Pima County; RLG 10794, Sierra Vista, Cochise County.

25. PHANEROCHAETE TUBERCULATA (Karst.) Parm. Conspect. Syst. Corticiacearum, p. 83. 1968.

Corticium tuberculatum Karst., Hedwigia 35:45. 1896.

Basidiocarps becoming broadly effused, adnate, membranous; hymenial surface tuberculate, deeply cracked when dry, Cinnamon-Buff to Clay-Color; margin thinning out, white, arachnoid; hyphal system monomitic, subicular hyphae (Fig. 25a) thin-walled, hyaline, simple-septate, sometimes incrusted, 3.5-5 µm diam; cystidia none; basidia (Fig. 25b) clavate, 4-sterigmate, simple-septate at base, 25-35 x 5-6 µm; basidiospores (Fig. 25c) ellipsoid, 6-9 x 3.5-5 µm,



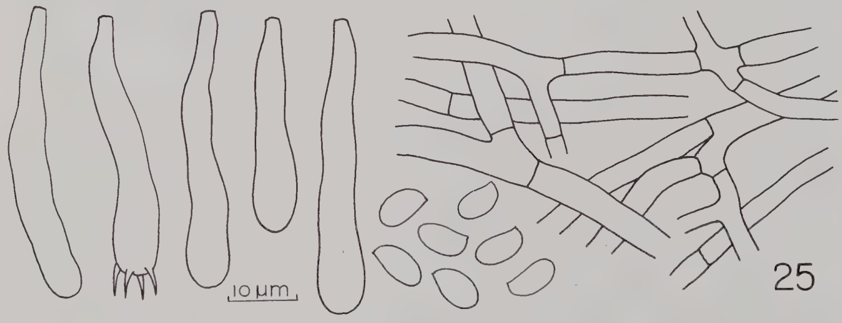


Fig. 24. *Phanerochaete chrysorhizon* (RLG 10391) a, simple-septate subicular hyphae; b, subicular hyphae with single clamps; c, subicular hypha with double clamp; d, cystidia; e, basidia; f, basidiospores. Fig. 25. *Phanerochaete tuberculata* (RLG 10082). a, subicular hyphae; b, basidia; c, basidiospores.

hyaline, smooth, negative in Melzer's reagent.

Phanerochaete tuberculata is associated with a white rot of dead branches or wood on the ground. It has been found on wood of a number of shrubs and trees in the Sonoran and Mohave deserts and plays an important role in the desert ecosystem.

Voucher specimens: RLG 10082, Cascabel, San Pedro River Rd., Cochise County; D. C. Rhodes P-016A, Patagonia, Santa Cruz County; HHB 5971, Redington, San Pedro Valley, Pima County.

26. PHLEBIA OCHRACEOFULVA (Bourd. et Galz.) Donk, Fungus 27:12. 1957.

Basidiocarps broadly effused, soft-waxy, adnate; hymenial surface pale pinkish-buff to orange-buff when fresh, drying light buff, slightly tuberculate, appearing pilose under 30X lens; hyphal system monomitic; subicular hyphae (Fig. 26a) somewhat agglutinated, thin-walled, hyaline, with clamps, some much contorted and irregularly lobed, up to 10 µm diam; cystidia (Fig. 26b) abundant, subulate, 18-22 x 4-5 µm, thin-walled, not incrusted, with a basal clamp; basidia (Fig. 26c) clavate, 4-sterigmate, 20-25 x 5-6 µm, with a basal clamp; basidiospores (Fig. 26d) oblong, 5-6.5 x 3-3.5 µm, hyaline, smooth, negative in Melzer's reagent.

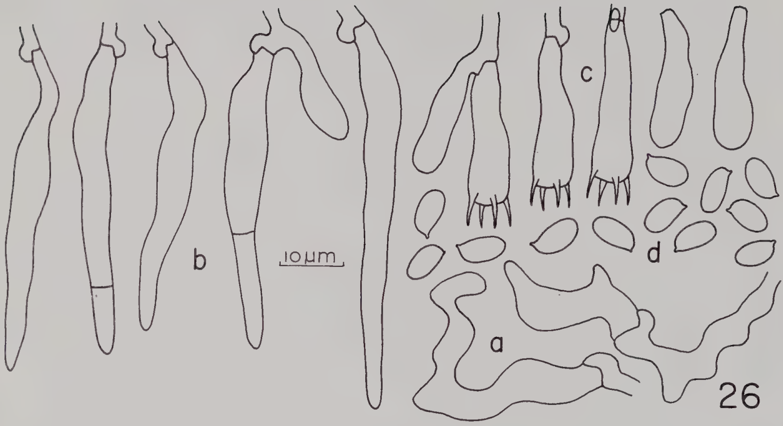
Phlebia ochraceofulva is associated with a white rot of fallen mesquite.

Voucher specimen: RLG 10494, Rest Area on Ariz. Highway 85 near Kitt Peak Rd., Pima County.

27. HENNINGSOMYCES CANDIDUS (Pers.) O. Kuntze, Rev. Gen. Pl. 3:483. 1898.

Solenia candida Pers., Myc. Eur. 1:334. 1822.

Basidiocarps consisting of individual tubes that are separate from each other or closely packed and confluent, white, minutely tomentose on the outer surface, about 600-700 µm long and 160-200 µm diam; apical pore usually conspicuous; hymenium continuous on inner surface, about 22 µm thick; hyphal system monomitic; hyphae (Fig. 27a) 2-4 µm diam, thin-walled, with simple septa and obscure clamps, agglutinated and difficult to separate; apically branched slender hyphae on outer surface (Fig. 27b), branched at the apex, 1.5-2 µm diam; fusiform cystidioles (Fig. 27c) abundant, up to 25 x 5 µm, scarcely projecting; basidia (Fig. 27d) broadly clavate, 14-17 x 6-7 µm; basidiospores (Fig. 27e) subglobose, 4 x 5 µm, hyaline, thin-walled,



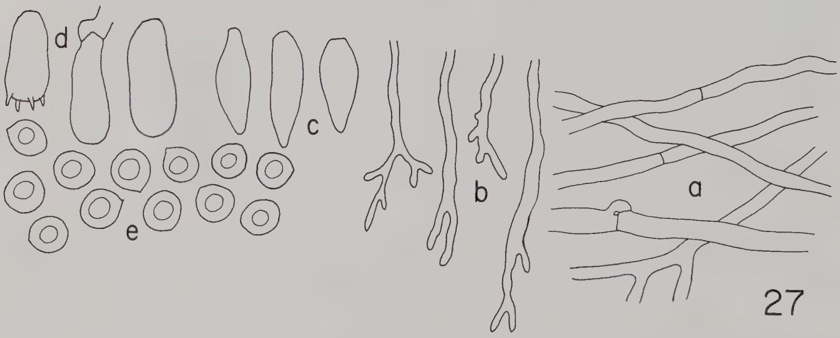


Fig. 26. *Phlebia ochraceofulva* (RLG 10494). a, subicular hyphae; b, cystidia; c, basidia; d, basidiospores. Fig. 27. *Henningsomyces candidus* (RLG 8437). a, hyphae from wall of basidiocarp; b, branching hyphae from outer surface of basidiocarp; c, fusoid cystidioles; d, basidia; e, basidiospores.

smooth, negative in Melzer's reagent.

Henningsomyces candidus is associated with a white rot of fallen stems.

Voucher specimen: RLG 8437, Sonoita Creek, 6 miles east of Patagonia, Santa Cruz County.

28. GANODERMA LUCIDUM (W. Curt. ex Fr.) Karst., Rev. Mycol. 3:17. 1881.

Basidiocarps annual, sessile to laterally substipitate, applanate, 15 cm or more broad, upper surface with thin varnished crust at maturity, dark reddish brown, typically covered with powdery layer of basidiospores deposited by air currents; margin acute, narrowly sterile below; context at first creamy white, becoming dark purple brown in older portions, zonate, up to 3 cm thick at base; tube layer purple-brown, sharply distinct from context, up to 1 cm thick; pore surface creamy white at first, becoming light buff, staining dark purple-brown on bruising; pores circular to angular, 4-5 mm, with thick dissepiments; pileus surface 25-30 µm thick, a dense palisade of clavate, reddish-brown, thick-walled hyphal end cells (Fig. 28c) up to 7-11 µm diam; hyphal system dimitic; contextual skeletal hyphae (Fig. 28b) hyaline to pale golden brown, thick-walled, aseptate, with frequent dendritic branching, branch tips tapering to less than 1 µm diam, main hyphae up to 7 µm diam; contextual generative hyphae (Fig. 28a) 2-2.5 µm diam, hyaline, thin-walled, with clamps; tramal skeletal hyphae (Fig. 28d) pale greenish brown, thick-walled, aseptate, 2-3.5 µm diam, also some slender, thick-walled, branching, hyaline, aseptate hyphae 1-1.5 µm diam; tramal generative hyphae 2-2.5 µm diam, hyaline, thin-walled; basidia (Fig. 28e) broadly ellipsoid, 12-15 x 10-11 µm, 4-sterigmate; basidiospores (Fig. 28f) ellipsoid, 9-12 x 5.5-8 µm, truncate at apex, pale brown in KOH, with thick, pitted exospore; negative in Melzer's reagent.

Ganoderma lucidum is associated with a white root and butt rot of living mesquite and is found on other native southwestern desert trees and exotic ornamental trees and shrubs. The basidiocarps develop at or near the ground line.

Voucher specimen: RLG 11223, Univ. Ariz. Farm, Campbell Avenue, Tucson, Pima County.

29. HYMENOCHAETE ARIDA Karst., in Sacc., Syll. Fung. 9: 228. 1891.

Basidiocarps resupinate, effused up to 12 cm, adnate;

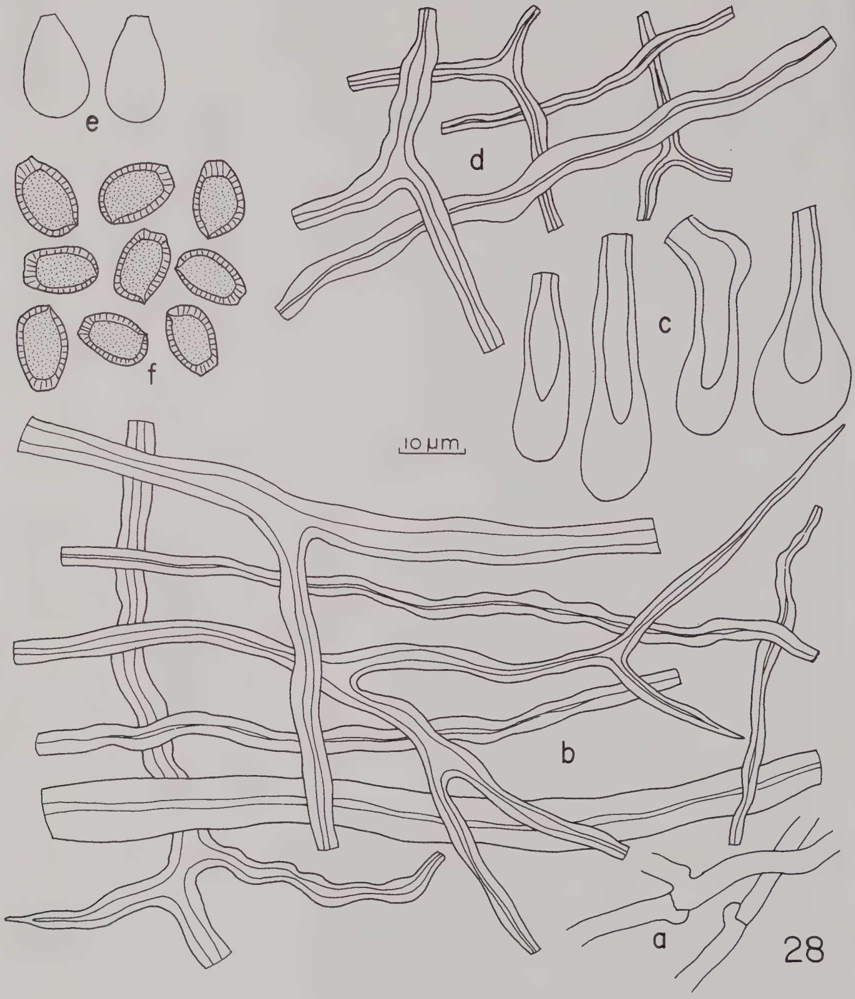


Fig. 28. *Ganoderma lucidum* (RLG 11223). a, contextual generative hyphae; b, contextual skeletal hyphae; c, thick-walled, clavate hyphal ends from pileus surface; d, tramal skeletal hyphae; e, basidia; f, basidiospores.

hymenial surface brown (Sudan Brown), smooth, setulose under 30X lens, margin abrupt, fertile; subicular hyphae (Fig. 29a) brown, darkening in KOH, simple-septate, moderately thick-walled, loosely arranged, with frequent branching, 3-5 µm in diam; setae (Fig. 29b) abundant, in a single layer, subulate, thick-walled, 60-100 x 5-8 µm, projecting

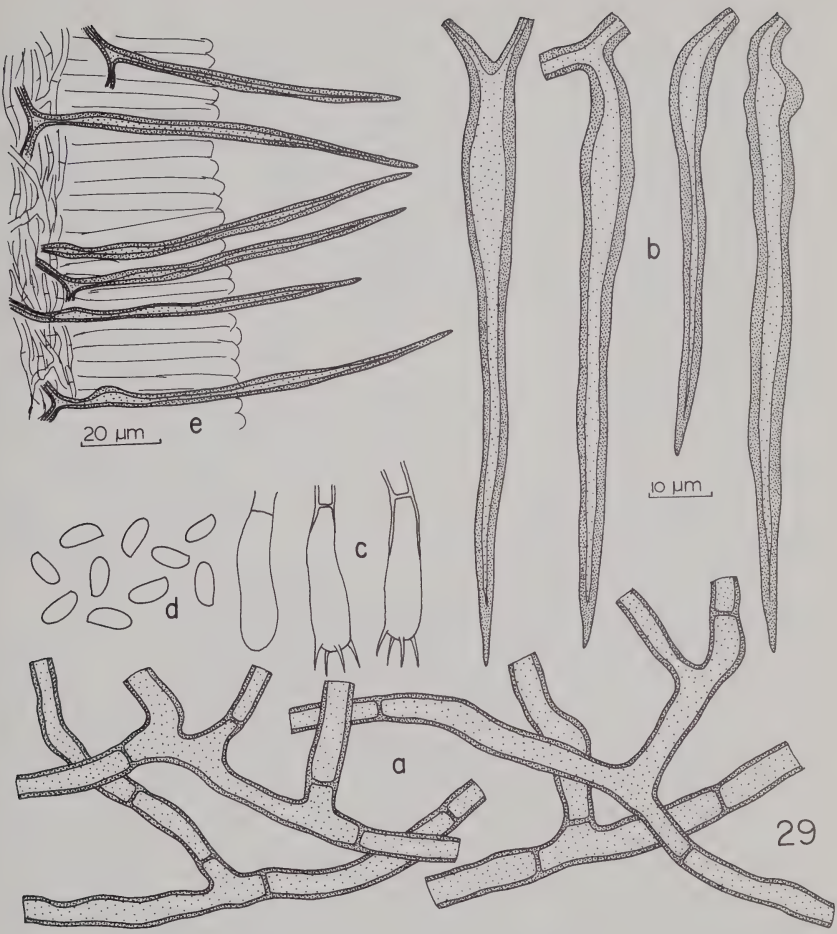


Fig. 29. *Hymenochaete arida* (HHB 8693). a, subicular hyphae; b, setae; c, basidia; d, basidiospores; e, schematic drawing of hymenium.

up to 60 µm, straight or curved; basidia (Fig. 29c) clavate, 4-sterigmate, 20-22 x 5-6 µm, with a basal septum; basidiospores (Fig. 29d) cylindric, 5-7 x 2-2.5 µm, hyaline, smooth, negative in Melzer's reagent.

Hymenochaete arida is associated with a white rot of hardwood and conifer logs and slash.

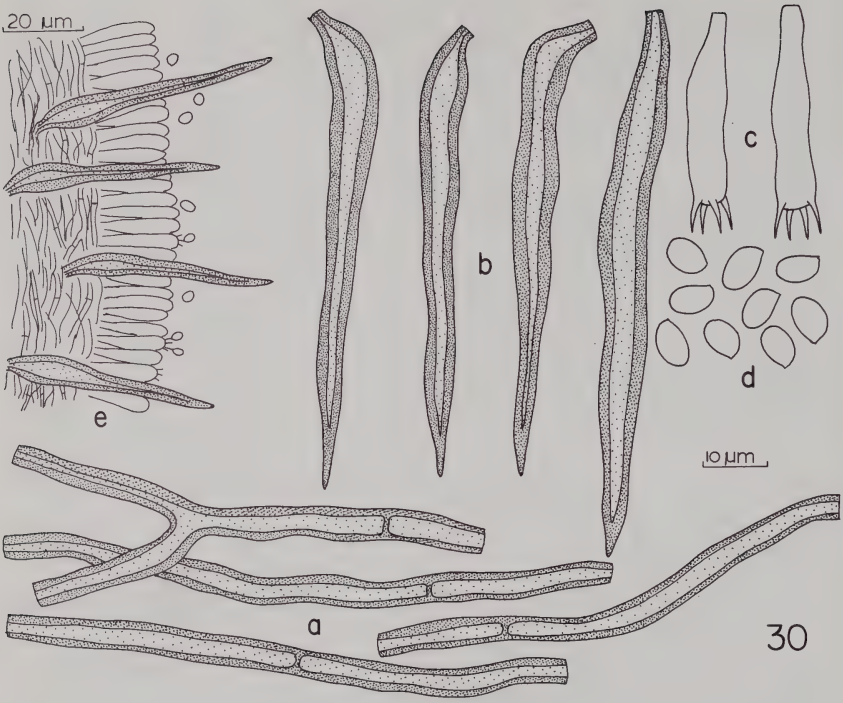


Fig. 30. *Hymenochaete rubiginosa* (RLG 10867). a, subicular hyphae; b, setae; c, basidia; d, basidiospores; e, schematic drawing of hymenium.

Voucher specimen: HHB 8693, Sycamore Canyon, Atascosa Mts., Santa Cruz County.

30. HYMENOCHAETE RUBIGINOSA Dicks. et Lév., Ann. Sci. Nat. Bot. ser. 3. 5:151. 1846.

Basidiocarps broadly effused to effused-reflexed, reflexed up to 5 mm; pileus thin, upper surface dark brown to dark reddish-brown, finely tomentose, concentrically zonate; hymenial surface Buffy Brown to Olive-Brown or Saccardo's Umber, smooth; margin sterile, reddish-brown with yellowish-brown outer edge; subicular hyphae (Fig. 30a) tightly interwoven, reddish-brown, 2-4 µm diam, thin- to thick-walled, simple-septate, darkening in KOH; setae (Fig. 30b) abundant, subulate, 60-80 x 5-7 µm, arising in subhymenium, thick-walled, reddish-brown, aseptate, darkening in KOH; basidia (Fig. 30c) broadly clavate, 25-30 x 5-6.5 µm, 4-sterigmate, hyaline at apex, yellow-brown at base; basidiospores (Fig. 30d) broadly ovoid, 5.5-7 x 3.5-4.5 µm, hyaline, thin-walled, smooth, negative in Melzer's reagent.

Hymenochaete rubiginosa is associated with a white root and butt rot of living mesquite. The basidiocarps develop at the ground line and are inconspicuous.

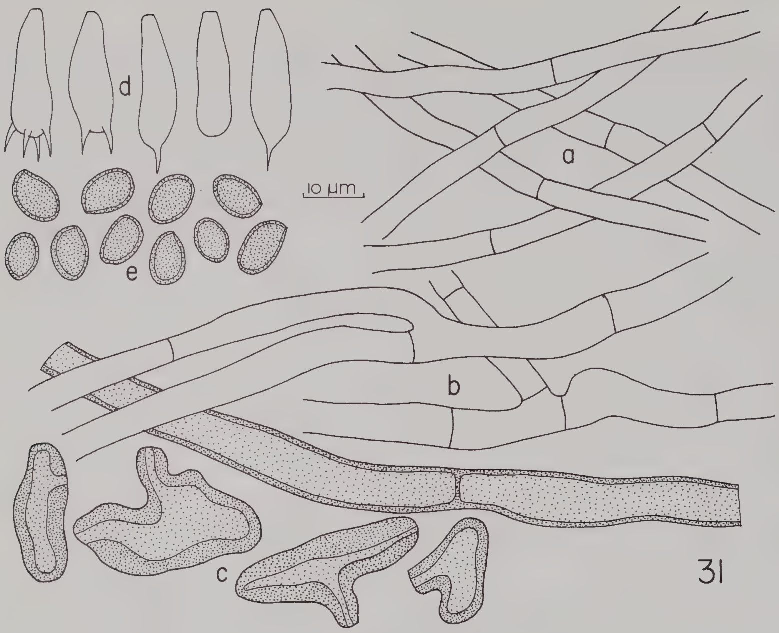
Voucher specimens: HHB 8417, at base of living mesquite, lower Sabino Canyon, Santa Catalina Mts., Pima County; RLG 10865, 10867 and 10872, at base of living mesquite, Lower Bear Canyon, Santa Catalina Mts., Pima County.

31. INONOTUS TEXANUS Murr., Torrey Bot. Club. Bul. 31:597. 1904.

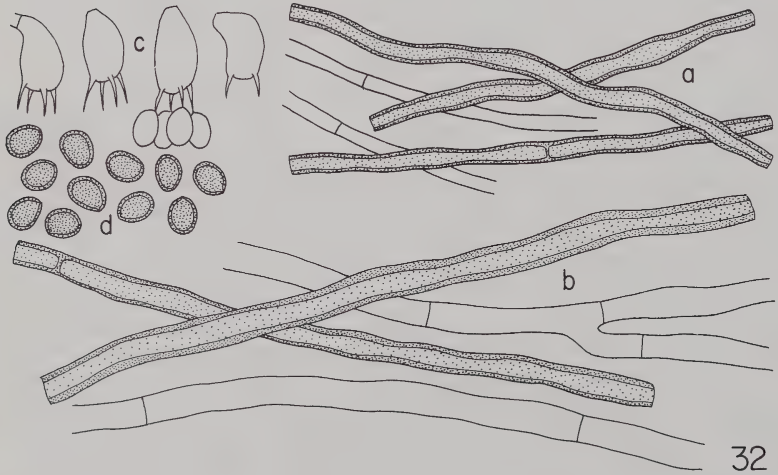
Basidiocarps annual, sessile, ungulate to applanate, up to 6 x 8 x 5 cm; upper surface pale brown, glabrous or soon becoming so, cracking radially and concentrically to form angular scales; context with distinct granular core of intermixed white and brown tissue; fibrous context yellowish-brown, up to 1 cm thick; tube layer concolorous with fibrous context, up to 3.5 cm thick, brittle; hyphae of fibrous context (Fig. 31b) hyaline to dark brown, thin- to thick-walled, simple-septate, some with rare branching, 3-6 µm diam, others contorted and much branched, 2.5-4 µm diam; hyphae of granular core (Fig. 31c) dark brown in KOH, thick-walled, contorted and swollen, breaking readily into short fragments up to 20 µm diam; tramal hyphae (Fig. 31a) mostly hyaline or pale yellowish, thin-walled, 2-4 µm diam; setae absent; basidia (Fig. 31d) clavate, 4-sterigmate, 7-8 µm diam; basidiospores (Fig. 31e) ovoid to broadly ellipsoid, 6-8(-9) x 5-6.5(-7) µm; dark yellowish-brown, with slightly thickened walls, negative in Melzer's reagent; spore print rusty brown.

Inonotus texanus causes a white rot of the heartwood of living trees. It is also found on catclaw acacia (*Acacia greggii* Gray), a common associate of mesquite in southern Arizona.

Voucher specimens: RLG 7043 and 7045, Santa Rita Expt. Range, Santa Rita Mts., Pima County; RLG 8947,



31



32

Fig. 31. *Inonotus texanus* (RLG 10508). a, tramal hyphae; b, hyphae from fibrous context; c, thick-walled, contorted hyphae from granular core; d, basidia; e, basidiospores. Fig. 32. *Phellinus badius* (RLG 7737). a, tramal hyphae; b, contextual hyphae; c, basidia; d, basidiospores.

Sonoita Creek, Santa Cruz County; ERC 174, Ruby, Atascosa Mts., Santa Cruz County; ERC 71-71, Old Spanish Trail near Colossal Cave, Pima County; RLG 10508 and 10510, Forestry Cabin Trail, Baboquivari Mts., Papago Indian Res., Pima County.

32. PHELLINUS BADIUS (Berk.) G. H. Cunn., New Zealand Dept. Sci. Ind. Res. Bull. 164. p. 233. 1965.

Fomes badius (Berk.) Cke., Grevillea 14:18. 1885.

Basidiocarps perennial, sessile, dimidiate, to 6 x 7 x 3.5 cm; upper surface quickly becoming blackened and rimose, margin yellowish-brown, tomentose, up to 1.5 cm wide; pore surface yellowish-brown, smooth; pores circular to angular, 3-5 per mm, with smooth, entire dissepiments; context bright yellowish-brown, firm, fissile, faintly zonate, up to 2 cm thick; tube layers concolorous, not distinct from context, up to 2 cm thick; contextual hyphae (Fig. 32b) simple-septate, some thin-walled, pale brown, 4-6 µm diam, some thick-walled, dark brown, 3-9 µm diam; tramal hyphae (Fig. 32a) similar; basidia (Fig. 32c) broadly clavate, up to 12-14 x 6-7 µm, sterigmata 5-6 µm long; setae absent; basidiospores (Fig. 32d) ovoid, 5-7 x 4-6 µm, dark reddish-brown with slightly thickened walls, negative in Melzer's reagent.

Phellinus badius causes a white rot of the heartwood of living trees. The decayed wood becomes pale yellow with brown mycelium developing in shrinkage cracks as decay progresses.

Voucher specimens: RLG 7834, Baboquivari Peak Rd., Papago Indian Res., Pima County; ERC 71-89, Sonoita Creek, Patagonia, Santa Cruz County; N. Simmons, Tule Desert, Yuma County; ERC 71-72, Colossal Cave Area, Rincon Mts., Pima County.

33. PHELLINUS FERRUGINOSUS (Schrad. ex Fr.) Bourd. et Galz., Hym. France. p. 625. 1928.

Poria ferruginosa (Schrad. ex Fr.) Karst., Rev. Mycol. 3, 9:18. 1881.

Basidiocarps annual or perennial, becoming widely effused, tough to soft-spongy, adnate; margin often appearing setulose under a lens, up to 2 cm wide; pore surface ferrugineous, the pores circular, usually 7-9 per mm, but in some unusual specimens 2-3 per mm, with thick, tomentose dissepiments; context yellowish-brown, azonate, soft-fibrous, up to 1.5 mm thick; tube layer slightly darker than the context or concolorous, continuous with the context, up to 2 mm thick; contextual hyphae (Fig. 33a) simple-septate, hyaline or pale yellow and thin-walled to dark brown and thick-walled, 2-4 µm diam; tramal hyphae similar; setal hyphae usually present in marginal tissue, dark reddish-brown, thick-walled, tapering to a point, unbranched, 5-8 µm diam; basidia (Fig. 33c) clavate, 4-sterigmate, 11-14 x 4.5-6.5 µm, hyaline, with a basal septum; setae (Fig. 33b) abundant in hymenium, mostly subulate, thick-walled, 25-65 x 6-8 µm; basidiospores (Fig. 33d) cylindrical or short-oblong, 5-7 x 3-3.5 µm, hyaline, smooth, negative in Melzer's reagent.

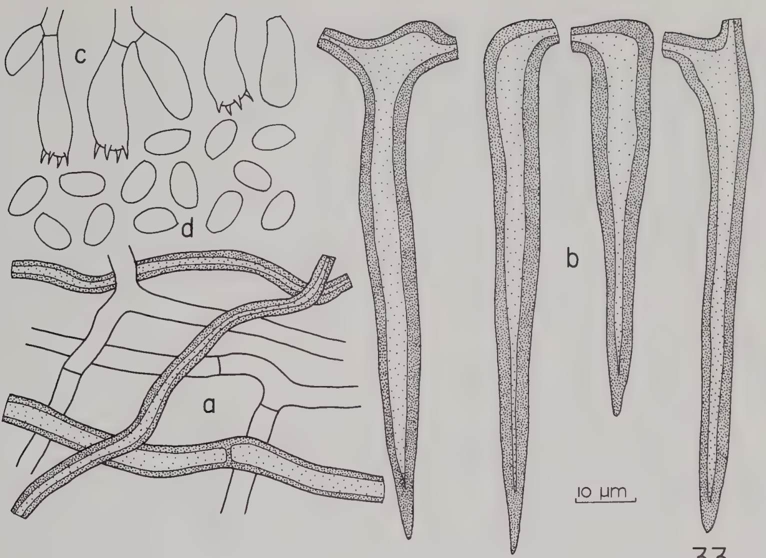
Phellinus ferruginosus causes a white rot of fallen trunks and branches.

Voucher specimens: RLG 7044, Santa Rita Expt. Range, Santa Rita Mts., Pima County; ERC 71-78, Redington-Benson Rd., San Pedro Valley, Cochise County; RLG 10385, and ERC 71-257, Aravaipa Canyon, Galliuro Mts., Pinal County.

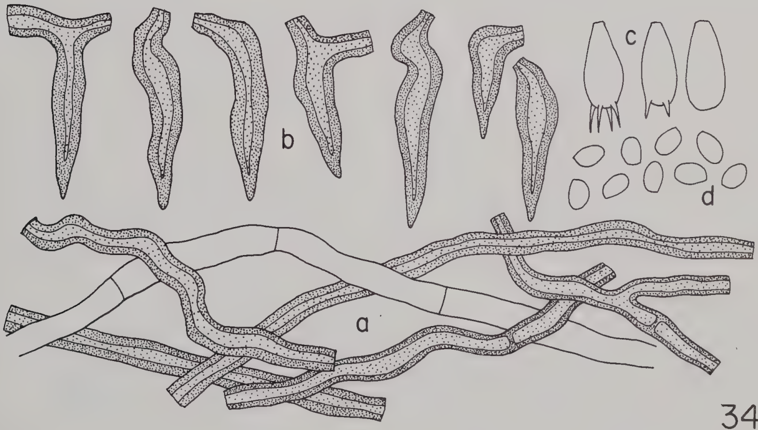
34. PHELLINUS GILVUS (Schw.) Pat., Ess. Tax. Hym., p. 97. 1900.

Polyporus gilvus (Schw.) Fr., Elench. Fung. 1:104. 1828.

Basidiocarps perennial or annual, sessile; upper surface pale yellowish-brown to reddish-brown and tomentose, becoming smooth to warted, blackening with age, sometimes zonate especially near margin; pore surface purplish-brown, pores circular, 6-8 per mm; context bright golden yellow, fibrous, up to 2 cm thick; contextual hyphae (Fig. 34a) pale yellow, thin-walled, and septate to reddish-brown, thick-walled, and infrequently septate, rarely branched, 2.5-6.5 µm diam; tramal hyphae similar; setae (Fig. 34b) abundant, subulate, 20-30 x 5-6 µm, reddish-brown, thick-walled, bifurcate or not at base, projecting up to 15 µm; basidia (Fig. 34c) broadly clavate, 8-11 x 5-7 µm, 4-sterigmate, with a basal septum; basidiospores (Fig. 34d)



33



34

Fig. 33. *Phellinus ferruginosus* (ERC 71-257). a, contextual hyphae; b, setae; c, basidia; d, basidiospores. Fig. 34. *Phellinus gilvus* (ERC 86). a, contextual hyphae; b, setae; c, basidia; d, basidiospores.

ovoid, hyaline, 4-5 x 2.5-3.5 µm, negative in Melzer's reagent.

Phellinus gilvus is a common fungus on a number of stream-bank hardwoods at lower elevations in southern

Arizona and causes a white heartrot of living trees and also decays dead standing and fallen trees. It causes a butt rot in living mesquite with basidiocarps inconspicuous near the ground line.

Voucher specimens: ERC 71-86, Sonoita Creek, Santa Cruz County; RLG 10869 and 10873, at base of living mesquite, Lower Bear Canyon, Santa Catalina Mts., Pima County.

35. VARARIA TROPICA Welden, Mycologia 57:516. 1965.

Basidiocarps annual, effused, cracking into small angular blocks on drying, soft and easily sectioned; hymenial surface pale buff, minutely tomentose under 30X lens, smooth or slightly tuberculate; margin thinning out, fertile; hyphal system dimitic; generative subicular hyphae (Fig. 35a) thin- to moderately thick-walled, hyaline, simple-septate, 2.5-4 µm diam; dichohyphidia (Fig. 35b) dextrinoid in Melzer's reagent, abundant, concentrated in a zone below the hymenial region but also scattered in lower subiculum, with thickened walls, profusely branched with ultimate branches tapering to slender curved apices, basal portion 2-4 µm diam and slender apices less than 1 um diam; gloeocystidia (Fig. 35c) mostly imbedded, elongated, cylindric or with swollen portions, negative in sulfuric benzaldehyde, thin-walled, 70-90 x 6-12 µm; basidia (Fig. 35d) in a catahymenium. arising from imbedded probasidia at different levels, thick-walled at base, 25 x 6-8 µm, 4-sterigmate; probasidia (Fig. 35e) globose to ellipsoid, 9-12 µm diam; basidiospores (Fig. 35f) subglobose to ellipsoid, 9-12 x 7-9 µm, hyaline, negative in Melzer's reagent, smooth, with slightly thickened wall and a blunt, prominent apiculus.

Vararia tropica was originally described from Puerto Rico, and has not been reported previously from western North America. It is associated with a white rot of dead branches.

Voucher specimen: RLG 10950, near Arizona State Rd. 289, 5 mi. west of Arivaca, Santa Cruz County.

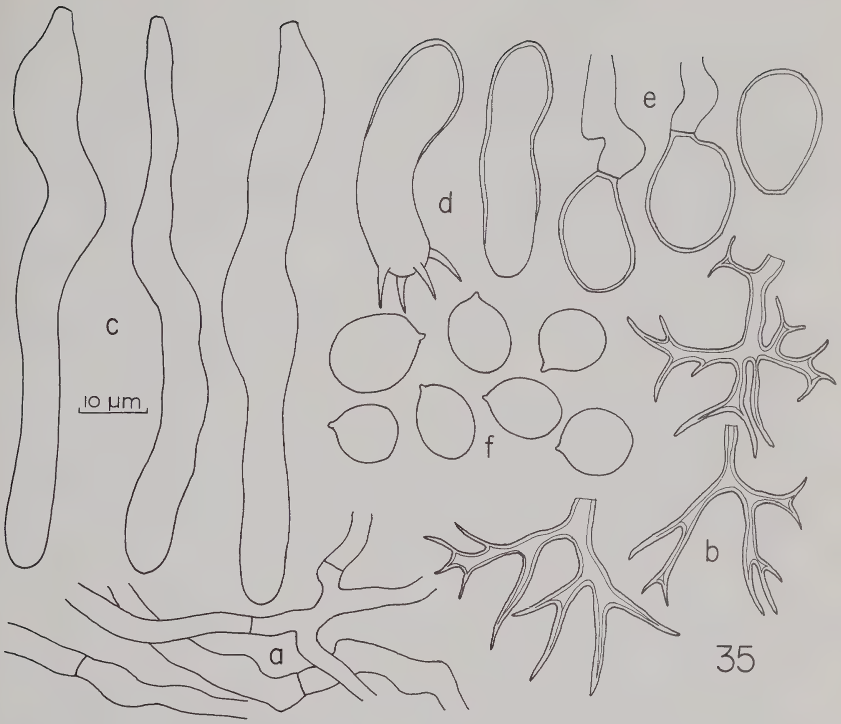


Fig. 35. *Vararia tropica* (RLG 10950). a, subicular hyphae; b, dichohyphidia; c, gloeocystidia; d, basidia; e, probasidia; f, basidiospores.

36. ANTRODIA HETEROMORPHA (Fr.) Donk, Persoonia, 4:339. 1966.

Trametes heteromorpha (Fr.) Bres., in Neuman, Wis. Geol. Nat. Hist. Sur. Bul. 33:40. 1914.

Basidiocarps annual, usually effused-reflexed, often effused or sessile; pilei solitary or imbricate; reflexed portion dimidiate to elongate, up to 3 x 20 x 1.5 cm; surface of pileus ivory white to pale brown, glabrous to slightly tomentose; margin even, sometimes abrupt, concolorous with pileus surface; pore surface concolorous with upper surface, dull, pores angular to circular, 1 to 3 per mm; dissepiments at first thick and entire, thin and lacerate with age; context ivory-colored, corky, up to 6 mm thick; hyphal system dimitic; generative contextual hyphae (Fig. 36a) thin-walled, with clamps, 2-4 µm diam; contextual skeletal hyphae (Fig. 36b) thick-walled, aseptate, 3-6 µm diam; tramal hyphae similar; basidia (Fig. 36c) clavate, 4-sterigmate, 30-40 x 9-10 µm; with a basal clamp; cystidia none; basidiospores (Fig. 36d) broadly cylindric, slightly curved, 12-16.5 x 5-7.5 µm, hyaline, smooth, negative in Melzer's reagent.

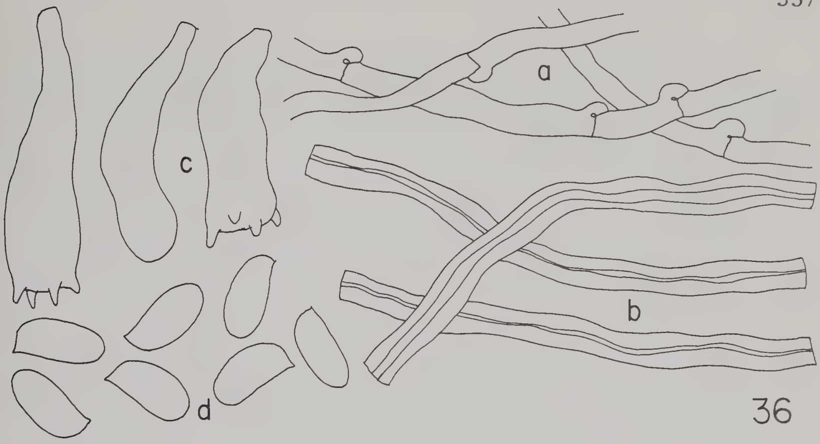
Antrodia heteromorpha is associated with a brown cubical rot of fallen and standing dead stems and branches.

Voucher specimens: RLG 10213 and 10216, Santa Rita Expt. Range, Santa Rita Mts., Pima County; ERC 71-79, Redington-Benson Rd., San Pedro Valley, Cochise County; ERC 71-255, Aravaipa Canyon, Pinal County; ERC 71-356, Camp Grant Wash, San Pedro Valley, Pinal County; HHB 5955, Redington Rd., Pima County.

37. POLYPORUS ARCULARIUS Batsch. ex Fr., Syst. Myc. 1: 342. 1821.

Basidiocarps annual, centrally stipitate; pilei circular, solitary, up to 2.5 cm diam and 0.3 cm thick; surface of pileus straw-colored to dark brown, azonate, glabrous, smooth to rugose; margin ciliate, acute, sterile below; stipe central, concolorous with pileus, glabrous, up to 3.5 cm long and 0.4 cm thick; pore surface cream-colored to buff, dull, rough, the pores hexagonal, radially aligned, 1-2 per mm, dissepiments thin, becoming lacerate; context white to buff, azonate, tough, less than 1 mm thick; tube layer concolorous and continuous with context, up to 2 mm thick; hyphal system dimitic; contextual generative hyphae (Fig. 37c) thin-walled, often branched, with abundant clamps, 2.5-5 µm diam; contextual skeletal hyphae (Fig. 37d) thick-walled, aseptate, with occasional branching, 2-11 µm diam; tramal hyphae (Fig. 37a,b) similar, not readily separable; hyphae on pileus surface slender, thin-walled, with clamps, 1-1.5 µm diam; cystidia none; basidia (Fig. 37e) clavate, 4-sterigmate 25-35 x 5-6 µm, with a basal clamp; basidiospores (Fig. 37f) cylindric, straight or slightly curved, 7-9 x 2.5-3.5 µm, hyaline, smooth, negative in Melzer's reagent.

Polyporus arcularius causes a uniform white rot of fallen dead hardwoods and is occasionally found on



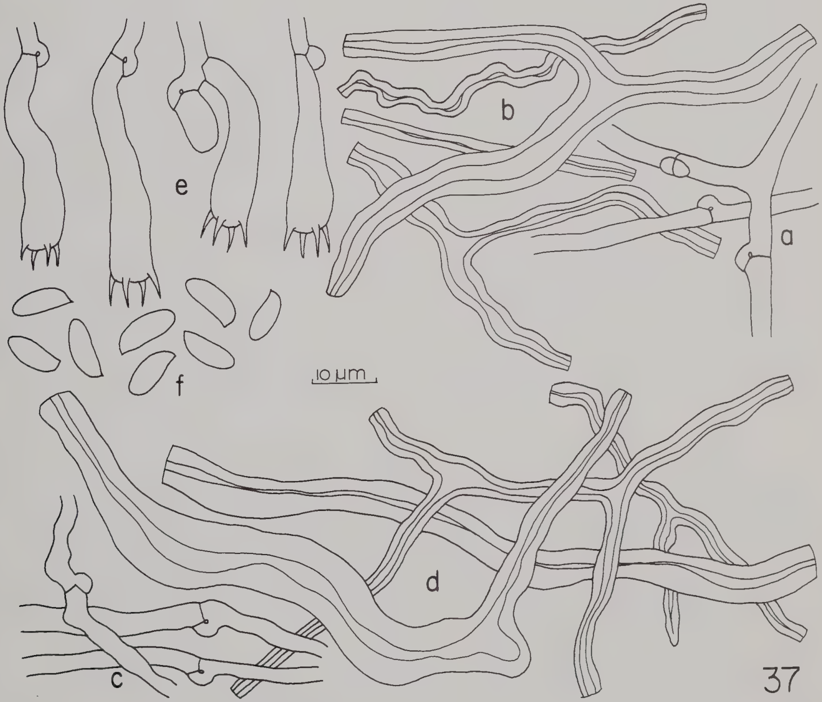


Fig. 36. *Antrodia heteromorpha* (RLG 9952). a, contextual generative hyphae; b, contextual skeletal hyphae; c, basidia; d, basidiospores. Fig. 37. *Polyporus arcularius* (RLG 7903). a, tramal generative hyphae; b, tramal skeletal hyphae; c, contextual generative hyphae; d, contextual skeletal hyphae; e, basidia; f, basidiospores.

junipers. It is especially common on oak in southern Arizona.

Voucher specimen: HHB 8481, Santa Rita Expt. Range, Santa Rita Mts., Pima County.

38. PORIA APACHERIENSIS Gilbertson et Canfield. Mycologia, 65:1117. 1973.

Basidiocarps annual, effused up to 10 cm, adnate, soft-fibrous; pore surface white to Cream Color or Light Buff, the pores irregular in shape, daedaloid in some areas, up to 1 mm diam but mostly 2-3 per mm; dissepiments thick and finely tomentose at first but becoming thick and deeply lacerate; tube layer soft-fibrous, white to cream colored, up to 2 mm thick; subiculum white, soft, azonate, less than 0.5 mm thick; hyphal system monomitic; subicular hyphae (Fig. 38a) with clamps, thin-walled, with occasional branching, 2-4 µm diam; tramal hyphae similar, incrusted at dissepiment edges; cystidia of two types, some acicular to cylindric (Fig. 38b), thin-walled, smooth or lightly incrusted, 3-5 µm diam and projecting up to 40 µm, others capitate (Fig. 38c), with stalk 3-5 µm diam and swollen apex up to 10 µm diam, projecting to 45 µm; basidia (Fig. 38d) clavate, 4-sterigmate, 18-21 x 6-7 µm; basidiospores (Fig. 38e) broadly ellipsoid to subglobose, 5-6.5 x 4-5.5 µm, hyaline, smooth, negative in Melzer's reagent.

Poria apacheriensis is associated with a white rot of dead fallen mesquite and other desert trees and shrubs. It has also been found associated with a root rot of several of these desert plants (Gilbertson and Canfield, 1973).

Voucher specimen: ERC 180, Patagonia, Santa Cruz County (TYPE).

39. PORIA BABOQUIVARIENSIS Gilbertson, sp. nov.

Fructificatio annua, resupinata, aurantiaca; pori angulati, 1-3 per mm; subiculum album, arachnoideum; margo alba, floccosa vel arachnoidea cum rhizomorphis; hyphae fibulatae et septatae, cum ampullae, 3-8 µm diam; cystidia tenuitunicata, cylindrica; basidia late clavata, 4-sterigmatibus, 7-9 µm diam; basidiosporae globosae vel late ellipsoidae, 5-6 x 4-5 µm, tunica echinulatae, hyalina, non-amyloidea; HOLOTYPUS: in ligno *Prosopis juliflora* (Sw.) DC., Arizona Highway 86 near Kitt Peak Rd., Pima County, Arizona, leg. R. L. Gilbertson No. 10503, in herb. CFMR.

ETYMOLOGY: from Baboquivari Mountains near the type locality.

Basidiocarps annual, effused up to 5 cm; pore surface orange when fresh, drying to orange-brown, the pores rounded to angular, up to 1 mm diam; margin whitish, arachnoid to floccose, with hyphal strands visible near the substratum, these continuing beyond the margin in some places, formed by a large central hypha surrounded by closely interwoven narrow hyphae; tubes soft and fragile when fresh, drying brittle, up to 2 mm long; subiculum white, arachnoid, very thin; hyphal system monomitic; subicular hyphae (Fig. 39a,b) thin-walled, with frequent branching, with clamp connections and simple septa, some ampullate, 3-8 µm diam; cystidia (Fig. 39c) thin-walled, often with clamps or simple septa, cylindric, scattered in hymenium and abundant at dissepiment edges, 3-5 µm diam, often with a swollen base up to 10 µm diam, projecting to 50 µm; basidia (Fig. 39d) broadly clavate, with a basal clamp, 7-9 µm diam; basidiospores (Fig. 39e) hyaline, negative in Melzer's reagent, subglobose to broadly ellipsoid, distinctly echinulate at maturity, with a large central guttule, 5-6 x 4-5 µm.

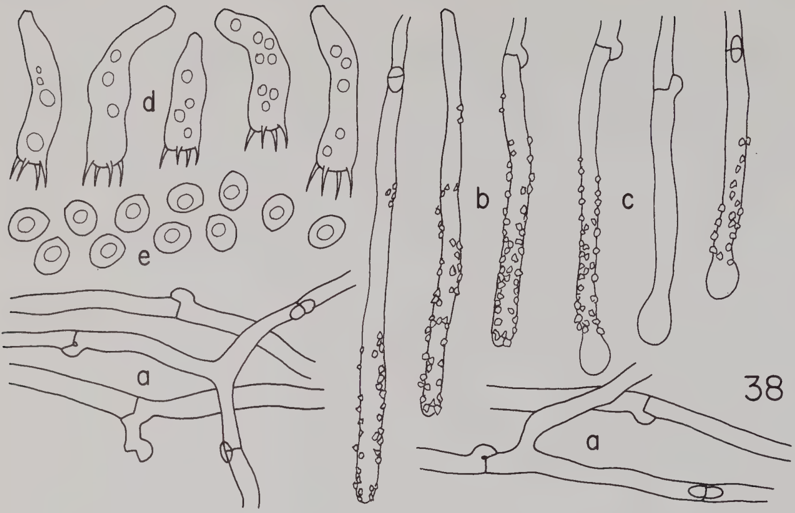
Poria baboquivariensis is associated with a white rot of dead, fallen mesquite. The distinctive characters are the orange color of the basidiocarp, the echinulate spores, and the ampullate hyphae. The latter two characters suggest a relationship to the genus *Trechispora* of the Corticiaceae.

Voucher specimen: holotype previously listed.

40. PORIA LATEMARGINATA (Dur. et Mont.) Cke., Grevillea 14:112. 1886.

Poria ambigua Bres., Accad. Rover. Agiati Atti ser. 3, 3:84. 1897.

Basidiocarps annual or rarely perennial, becoming



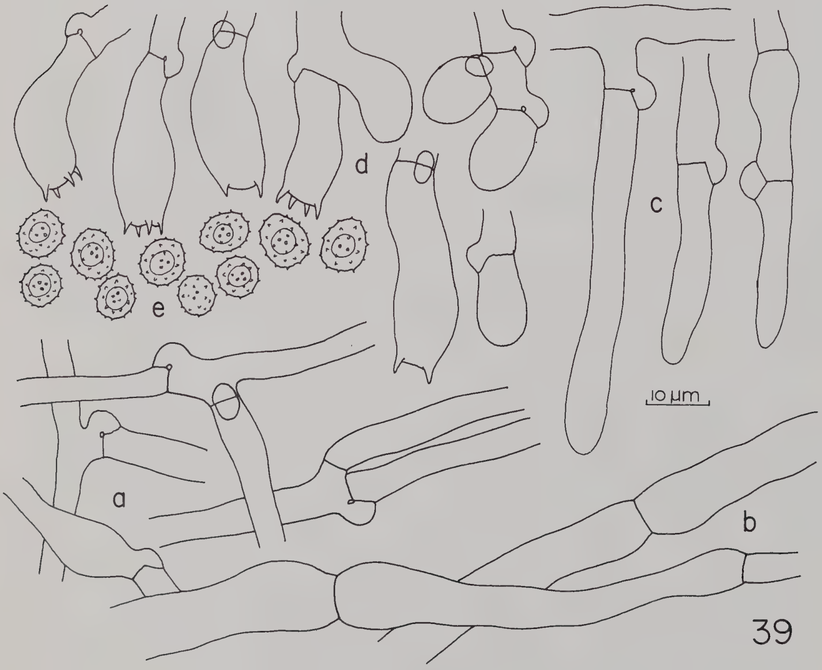


Fig. 38. *Poria apacheriensis* (ERC 180). a, subicular hyphae; b, cylindric cystidia; c, capitate cystidia; d, basidia; e, basidiospores. Fig. 39. *Poria baboquivariensis* (RLG 10503). a, nodose-septate subicular hyphae; b, simple-septate subicular hyphae; c, cystidia; d, basidia; e, basidiospores.

widely effused, adnate; pore surface cream-colored to pale tan, the pores angular, 1-3 per mm; subiculum ivory, soft-fibrous; hyphal system monomitic; subicular hyphae (Fig. 40a) hyaline, single septate, thin-walled to relatively thick-walled, often partially incrusted, 3-10 µm diam; cystidia frequent or rare, to absent, cylindrical to clavate, entirely or capitately incrusted, 17-25 x 5-7 µm; basidia (Fig. 40b) clavate, 4-sterigmate, 20-25 x 6-7 µm, with a basal septum; basidiospores (Fig. 40c) broadly ellipsoid to ovoid, 5-8 x 3-5 µm, hyaline, smooth, negative in Melzer's reagent.

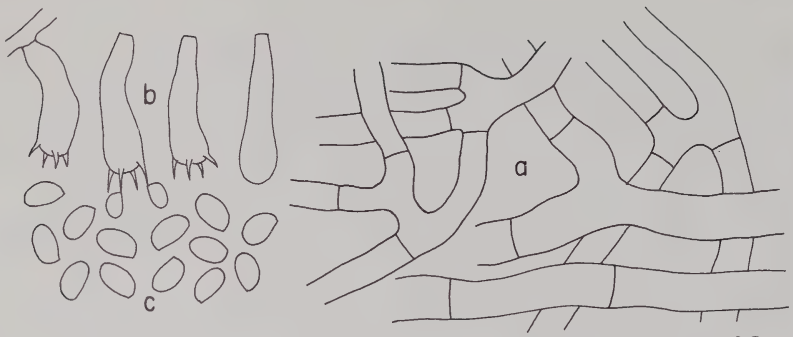
Poria latemarginata is associated with a white rot of dead hardwoods. Collection RLG 10843 was from the base of a recently killed standing mesquite and was associated with a root and butt rot.

Voucher specimens: RLG 10843, Vail Road near Pantano Wash, Pima County; RLG 10843, Aravaipa Canyon, Galluiro Mts., Pinal County.

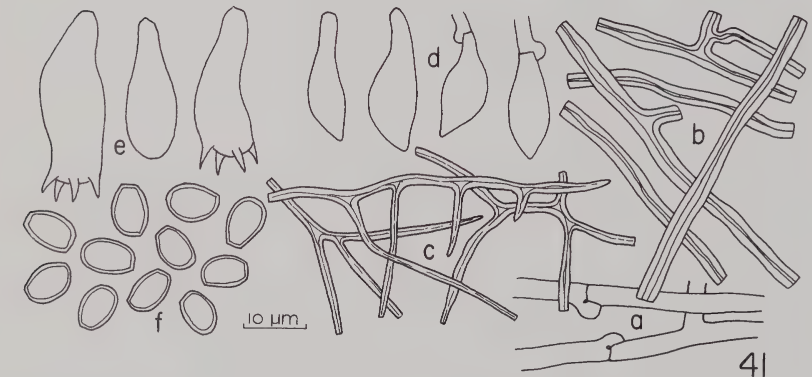
41. PORIA MEDULLA-PANIS (Jacq. sensu Pers.) Bres., Accad. Rover. Agiati Atti ser. 3, 3:84.

Basidiocarps annual or perennial, usually effused but sometimes narrowly reflexed on vertical surfaces, tough-corky; pore surface cream-colored to yellow, drying pale buff on some specimens, the pores circular, 5-7 per mm; dissepiments thick, entire; hyphal system trimitic; subicular generative hyphae (Fig. 41a) with clamps, thin-walled, with occasional branching, 3-4 µm diam; subicular skeletal hyphae (Fig. 41b) thick-walled, aseptate, rarely branched, 3-4 µm diam; binding hyphae (Fig. 41c) thick-walled, often dextrinoid in Melzer's reagent, aseptate, mostly with abundant branching, tips of branches tapering down to a very slender tip, (0.5-)1-2 µm diam; tramal hyphae similar; hyphal pegs present; fusoid cystidioles (Fig. 41d) 15-20 x 6-8 µm, with a basal clamp; basidia (Fig. 41e) broadly clavate, 4-sterigmate, 20-27 x 9-10 µm, with a basal clamp; basidiospores (Fig. 41f) 6-8 x 4.5-6 µm, ovoid to ellipsoid, becoming truncate and thick-walled at maturity, with a germ pore at the truncate end, hyaline, weakly to strongly dextrinoid in Melzer's reagent.

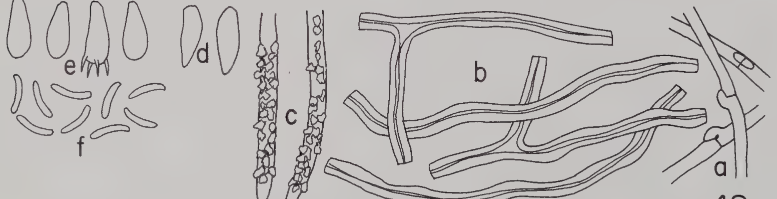
Poria medulla-panis is associated with a white rot of hardwood logs and stumps and is a common fungus from the



40



41



42

Fig. 40. *Poria latemarginata* (RLG 10843). a, subicular hyphae; b, basidia; c, basidiospores. Fig. 41. *Poria medulla-panis* (RLG 8459). a, subicular generative hyphae; b, subicular skeletal hyphae; c, slender binding hyphae; d, fusoid cystidioles; e, basidia; f, basidiospores. Fig. 42. *Poria subincarnata* (KJM 310). a, subicular generative hyphae; b, subicular skeletal hyphae; c, incrusted hyphal ends at dissepiment edges; d, fusoid cystidioles; e, basidia; f, basidiospores.

desert up through the oak-woodland zone in southern Arizona.

Voucher specimens: RLG 7782, Saguaro Nat. Monument, East Unit, Pima County; RLG 8459, Buenos Aires, Papago Indian Res., Baboquivari Mts., Pima County; RLG 10495, Rest area near Kitt Peak Rd., Highway 86, Pima County.

42. PORIA SUBINCARNATA (Pk.) Murr., Mycologia 13:86. 1921.

Basidiocarps annual, becoming broadly effused, separable or somewhat adnate, often cracking upon drying; taste mild; margin narrow, white, tomentose to fimbriate; pore surface creamy-white or with a pink tint when fresh, drying cream to buff, tubes soft-waxy to coriaceous, to 4 mm in length, the pores 4-7 per mm; subiculum soft, thin, white; hyphal system dimitic; subicular skeletal hyphae (Fig. 42b) thick-walled, aseptate, 2-3.5 µm diam; subicular generative hyphae (Fig. 42a) with clamps, 2-3 µm diam; tramal hyphae (Fig. 42c) similar, heavily incrusted at the dissepiment edges; conspicuous hyphal pegs present; fusoid cystidioles (Fig. 42d) 9-11 x 3-4 µm; basidia (Fig. 42e) clavate, 4-sterigmate, 9-11 x 4-5 µm, with a basal clamp; basidiospores (Fig. 42f) allantoid, 4-5 x 1-1.5 µm, hyaline, smooth, negative in Melzer's reagent.

Poria subincarnata is associated with a white rot of conifer, and rarely hardwood logs and slash. White rhizomorphs are sometimes present in bark and between bark and wood under basidiocarps.

Voucher specimen: RLG 7041, Madera Canyon, Santa Rita Mts., Pima County.

43. PORIA TARDA (Berk.) Cke., Grevillea 14:109. 1886.

Basidiocarps becoming broadly effused, annual, usually adnate, up to 1 mm thick; pore surface rose-pink to cream, usually drying cream to pale buff, tubes originating as isolated cupules; pores 3-5 per mm; 0.5-1 mm long; sterile margin usually rather wide, thinning out, white to cream; context white to cream, soft, very thin; tube layer concolorous with subiculum, 0.5-1 mm thick; hyphal system monomitic; subicular hyphae (Fig. 43a) hyaline, thin-walled, simple-septate, lacking clamps or with rare clamps, often slightly ampullate at the septa, frequently branched at right-angles, frequently lightly incrusted, 3.5 µm diam; tramal hyphae similar; cystidia none; basidia (Fig. 43b) clavate, 4-sterigmate, 16-18 x 4-5 µm, simple-septate at base; basidiospores (Fig. 43c) 4-5 x 2-2.5 µm, cylindric, ellipsoid, hyaline, thin-walled, smooth, negative in Melzer's reagent.

Poria tarda is associated with a white rot of fallen conifer and hardwood branches and stems.

Voucher specimen: HHB 5970, Redington, San Pedro River Valley, Pima County.

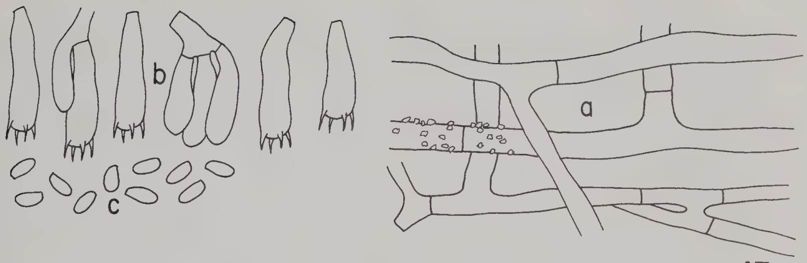
44. FUNALIA GALLICA (Fr.) Bond. et Sing., Ann. Mycol. 39: 62. 1941.

Trametes hispida Bagl., Erb. Crittog. Ital., no. 1356. 1866.

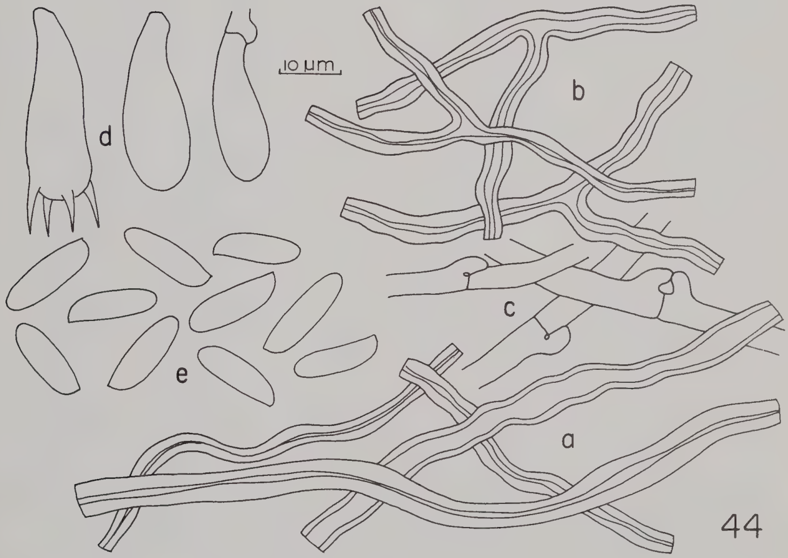
Basidiocarps annual, effused-reflexed to sessile, occasionally completely effused; pilei dimidiate, up to 10 cm wide; upper surface hispid, pale brown, azonate or faintly zonate; pore surface pale purplish (Drab to Light Drab); pores angular, over 1 mm diam in some specimens; dissepiments thick at first, tomentose, becoming thin and lacerate; hyphal system trimitic; contextual generative hyphae (Fig. 44c) inconspicuous, thin-walled, hyaline to pale yellow, septate and with clamps, rarely branched, 2-2.5 µm diam; contextual skeletal hyphae (Fig. 44a) conspicuous, slightly to strongly thick-walled, pale greenish-brown, aseptate, rarely branched, 2-3 µm diam; cystidia none; basidia (Fig. 44d) clavate, 4-sterigmate, 24-30 x 8-10 µm; basidiospores (Fig. 44e) 11-16 x 4-5 µm, cylindric, hyaline, thin-walled, negative in Melzer's reagent.

Funalia gallica is associated with a uniform white rot of dead standing or fallen hardwoods. It is common on several hardwoods, including Fremont cottonwood (*Populus fremontii* S. Wats) and Arizona sycamore (*Platanus wrightii* S. Wats.), but rare on mesquite in southern Arizona.

Voucher specimen: RLG 10396, Aravaipa Canyon, Pinal County.



43



44

Fig. 43. *Poria tarda* (RLG 10135). a, subicular hyphae; b, basidia; c, basidiospores. Fig. 44. *Funalia gallica* (RLG 10396). a, contextual skeletal hyphae; b, contextual binding hyphae; c, contextual generative hyphae; d, basidia; e, basidiospores.

45. LOPHARIA CRASSA (Lév.) Boidin, Bull. Soc. Mycol. France 74:479. 1958.

Basidiocarps effused up to 20 cm, annaul, adnate, hymenial surface smooth, bright purple at maturity, drying near Taupe Brown or Anthracene Purple, eventually becoming brown and rimose with age, hymenial layer cracking to expose the pale buff subiculum; hyphal system monomitic; subicular hyphae (Fig. 45a) oriented parallel to substrate, simple-septate, thin- to moderately thick-walled, with frequent branching, 3-5 µm diam; cystidia (Fig. 45b) abundant, thick-walled, imbedded or projecting up to 45 µm, fusiform, usually incrusted over the apical half, 60-180 x 8-12 µm, originating from horizontally oriented hyphae of subiculum, curving out parallel with the basidia; basidia (Fig. 45c) narrowly clavate, with a basal septum, 28-40 x 5-6 µm; basidiospores (Fig. 45d) cylindric, 7-9 x 3-4 µm, hyaline, thin-walled, negative in Melzer's reagent.

Lopharia crassa is associated with a white rot of dead fallen stems of desert plants.

Voucher specimens: RLG 10493 and 10502, Rest Area near Kitt Peak Rd., Highway 86, Pima County; RLG 10537, ERC 71-357, Camp Grant Wash, San Pedro Valley, Pinal County; HHB 5968, Redington, San Pedro Valley, Pima County.

46. TOMENTELLA COERULEA (Bres.) Hoehn. et Litsch., Sitzungs. kaiserl. Akad. Wissensch. Wien, Math.-naturw. Klasse 116:831. 1907.

Basidiocarps effused up to 2 cm, fragile, arachnoid, smooth or slightly granulose, easily separated from substratum; hymenial surface Cinnamon-Buff to Chamois, discontinuous; margin with slender white mycelial strands; subicular hyphae (Fig. 46a) mostly with clamps, thin-walled to slightly thick-walled, yellow-brown, with crystalline material dissolving, becoming green in KOH, 3-6 µm diam; cystidia none; basidia (Fig. 46b) cylindric to clavate, 4-sterigmate, sometimes with transverse septa, contents often red in H_2O, walls yellow-brown in KOH, surface granular materials dissolving and becoming green in KOH, 50-60 x 6.5-7 µm; basidiospores (Fig. 46c) subglobose to globose, 5.5-7 µm in diam, echinulate, pale brown, negative in Melzer's reagent.

The associated rot is unknown but probably of little importance in the decay of mesquite.

Voucher specimen: RLG 10515, Rest area near Kitt Peak Rd., Highway 86, Pima County.

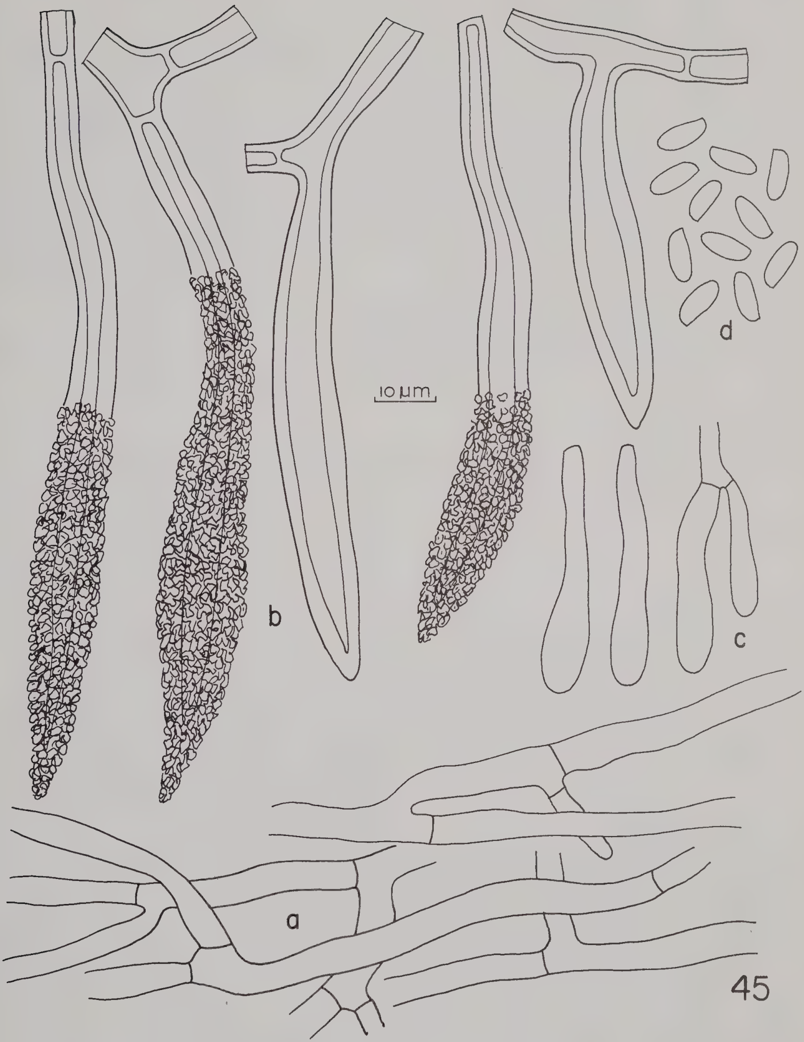
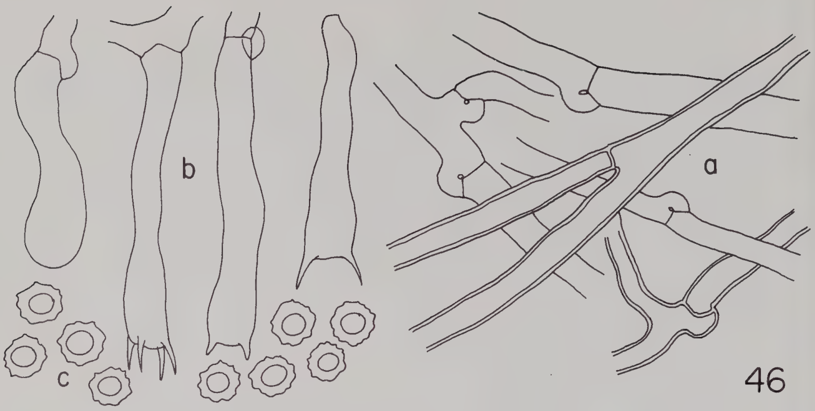


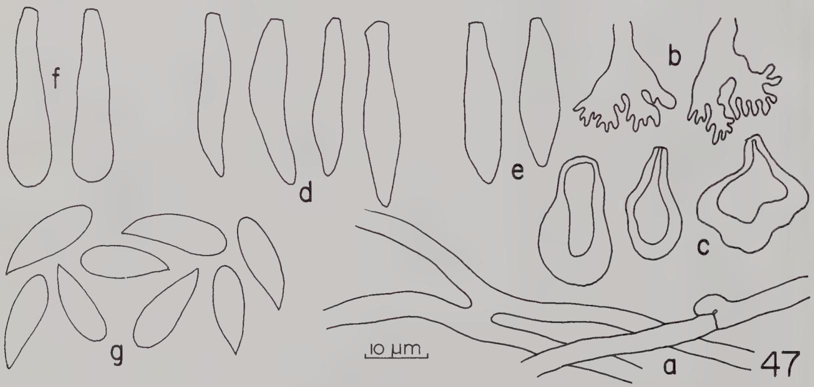
Fig. 45. *Lopharia crassa* (RLG 10502). a, subicular hyphae; b, cystidia; c, basidia; d, basidiospores.

47. MARASMIUS SICCUS (Schw.) Fr., Epicr. Syst. Mycol. p. 382. 1836.

Basidiocarps centrally stipitate, reviving; pileus hemispherical, up to 4 mm diam, thin, fragile; upper surface reddish-brown, plicate-striate; gills cream-colored,



46



47

Fig. 46. *Tomentella coerulea* (RLG 10515). a, subicular hyphae; b, basidia; c, basidiospores. Fig. 47. *Marasmius siccus* (HHB 8483). a, contextual hyphae; b, broom cells; c, thick-walled hyphal ends from upper surface; d, pleurocystidia; e, cheilocystidia; f, basidia; g, basidiospores.

adnate, dry, subdistant; stipe 10-15 mm long and 0.5 mm diam, tough-cartilaginous, brown, with appressed darker fibrils, shiny; pileus cuticle composed of dark reddish-brown, variously-shaped, irregularly thick-walled broom cells up to 13 μm diam (Fig. 47b), with few to numerous pale yellow to hyaline finger-like projections; thick-walled, brown swollen hyphal ends also present on upper surface (Fig. 47c); contextual hyphae (Fig. 47a) hyaline, thin-walled, tightly interwoven, 2.5-5 μm, with clamp connections; gill trama similar; pleurocystidia (Fig. 47d) cylindric, tapered to apex, hyaline, thin-walled, 24-28 x 4.5-6 µm, with basal clamp; cheilocystidia (Fig. 47e) cylindric, slightly tapered at apex, 22-25 x 5-6 µm; broom cells also present on gill edges; basidia (Fig. 47f) clavate, 26-27 x 7-7.5 µm, hyaline, with a basal clamp; basidiospores (Fig. 47g) narrowly lacrymiform, adaxially flattened, 13-16 x 4-5 µm, hyaline, thin-walled, negative in Melzer's reagent.

Marasmius siccus was found on fallen mesquite twigs. It has not been reported on other Sonoran Desert plants and the associated rot is unknown.

Voucher specimen: HHB 8483, Santa Rita Expt. Range, Santa Rita Mts., Pima County.

48. PANUS FULVIDUS Bres., Fungi Trid. II, p. 56. 1900.

Basidiocarps centrally stipitate, single to gregarius; pileus circular to hemispherical, 0.5-3 cm diam; upper surface dry, pale brown (Cinnamon-Buff to Clay Color) or cream colored with scattered pale brown, radially arranged fibrillar scales; stipe equal, 10-20 x 1-2 mm, cream colored to pale brown, usually darker at the base, glabrous to minutely pubescent; gills pinkish-cream to pale buff when dried, distant, edges sinuous and distinctly granulose under 30 X lens, free to adnate, continuous with striations on upper stipe; contextual hyphae (Fig. 48a) filamentous, simple-septate, thin- to thick-walled, 3-5 µm diam; hyphae of gill trama (Fig. 48b) thin-walled, simple-septate, 2-4 µm diam; pleurocystidia (Fig. 48c) fusoid, barely projecting, 45-50 x 5-6 µm; cheilocystidia similar; basidia (Fig. 48d) clavate, 4-sterigmate, 38-42 x 7-8 µm; with a basal septum; basidiospores (Fig. 48e) broadly cylindric, 12-15 x 6-6.5 µm, hyaline, smooth, negative in Melzer's reagent.

Panus fulvidus is associated with a brown cubical rot of dead hardwood trees and shrubs and is commonly found on junipers and juniper fence posts in southern Arizona.

Voucher specimen: ERC 71-158, Redington, San Pedro Valley, Pima County.

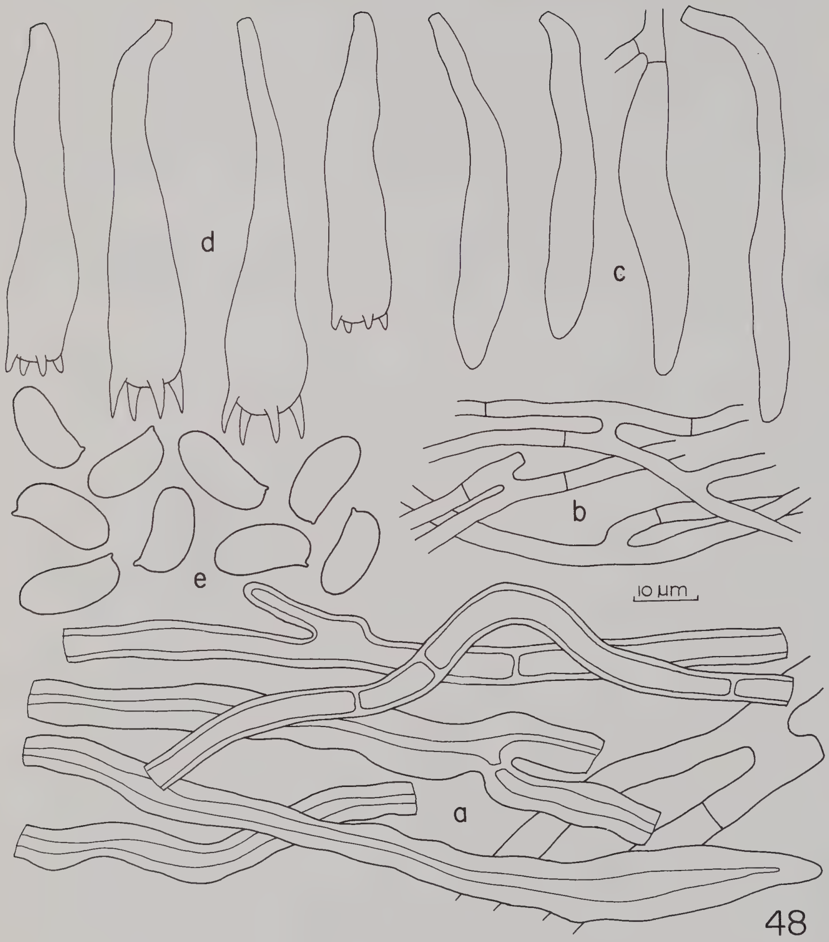

d
c
b
e
10 µm
a
48

Fig. 48. *Panus fulvidus* (ERC 71-132). a, contextual hyphae; b, tramal hyphae; c, pleurocystidia; d, basidia; e, basidiospores.

LITERATURE CITED

Benson, Lyman. 1941. The mesquites and screw-beans of the United States. Amer. J. Bot. 28:748-754.

Gilbertson, R. L., and H. H. Burdsall, Jr. 1975. *Peniophora tamaricicola* in North America. Mycotaxon 2:143-150.

Gilbertson, R. L., and E. R. Canfield. 1973. A new *Poria* from southern Arizona. Mycologia 65:1117-1124.

Gilbertson, R. L., K. J. Martin, and J. P. Lindsey. 1974. Annotated check list and host index for Arizona wood-rotting fungi. Univ. Ariz. Agr. Expt. Sta. Tech. Bul. 209. 48 p.

Jülich, Walter. 1974. The genera of the Hyphodermoideae (Corticiaceae). Persoonia 8:59-97.

Ridgway, Robert. 1912. Color standards and color nomenclature. Washington, D. C. Published by the author.

BOOK REVIEWS *(continued from page 486)*

A CONTRIBUTION TO THE TAXONOMY OF THE GENUS TOMENTELLA par Michael J. LARSEN, 6 + 145 p., 173 figs. photogr. bl.-n. Mycologia Memoirs, No. 4, 1974. The Mycological Society of America, c/o The New York Botanical Garden, Bronx, NY 10458. $9.- (USA), 10.- (Foreign).

L'auteur, dont les travaux sur les *Tomentella* d'Amérique du Nord sont bien connus, présente maintenant un travail de synthèse où il classe les 72 espèces nord-américaines dans les 14 sections, dont 9 nouvelles, du genre *Tomentella*. Deux espèces et seize combinaisons aussi sont nouvelles.

Ce travail résulte de l'examen de près de 1200 échantillons en provenance du monde entier.

En plus de la qualité de la taxonomie des espèces, on remarquera l'attention de l'auteur à rechercher les affinités de *Tomentella* avec les autres genres de Thelephoraceae, en particulier *Pseudotomentella*, *Tomentellina*, *Tomentellastrum* et *Thelephora*.

Un longue liste de Nomina excludenda, avec commentaires de l'auteur, vaut la peine d'être consultée.

Un travail qui, espérons-le, contribuera beaucoup à une monographie générale des *Tomentella*.

RAMARIA SUBGENUS LENTORAMARIA WITH EMPHASIS ON NORTH AMERICAN TAXA, par Ronald H. PETERSEN, 161 p., 18 figs., 15 pl. photogr. coul. et bl.-n., 14 × 22 cm, broché. Bibliotheca Mycologia 43, 1975, ed. J. Cramer, FL-9490 Vaduz, Liechtenstein. DM 50.-

Eclairer d'une lumière nouvelle ce groupe d'espèces qui si souvent dans le passé ont été confondues, n'est pas une tâche facile. L'auteur cependant y excelle, grâce à une très grand souci de précision et de clarté dans l'observation des caractères et leur usage pour la taxonomie.

L'auteur a voulu se cantonner aux espèces nord-américaines, mais la référence aux espèces voisines et aux synonymes l'amène, par l'étude des types, à fournir une documentation importante sur de nombreuses espèces extra-nord-américaines, ce qui donne à son livre une portée générale apréciable.

CHEMISCHE FARBREAKTIONEN VON PILZE, par A. MEIXNER, 286 p., 16 × 22 cm., 1975, ed. J. Cramer, FL-9490 Vaduz, Liechtenstein. DM 29.50.

The author offers a compilation of the color reactions to chemicals and to the air, as observed in the field and under the microscope, of the larger Ascomycetes and the Basidiomycetes. Thirty-six reactives are considered. The response of the fungi up to seven of these reactives is arranged in taxonomic tables. A special chapter concerns the oxydative reaction of the fungi to the air.

(continued on page 558)

MYCOTAXON

Vol. III, No. 3, pp. 553-557 April-June 1976

PUCIOLA SPINOSA, A NEW DEMATIACEOUS HYPHOMYCETE FROM SOIL

M. de Bertoldi

Istituto di Microbiologia Agraria, Università di Pisa, Centro di Studio per la Microbiologia del Suolo, CNR, Pisa, Italia.

ABSTRACT

Puciola spinosa n. gen. n. sp., a new dematiaceous hyphomycete, originating from sandy soil in Italy is described. Its most distinctive features are the needle-shaped erect conidiophores and its peculiar conidiogenous cells which on aging become conidiophores supporting conidia only on new lateral conidiogenous cells.

This new dematiaceous hyphomycete has been isolated, in one sample, from soil originating from sandy bank of the river Arno near Pisa, Italy, by plating soil suspension on Mycological agar (Difco) and keeping the plates for two weeks at 26° C.

This fungus appears to be unusual in its features and particularly in its conidiophores and conidiogenous cells. None of the dematiaceous hyphomycetes seem to have similar characters.

DESCRIPTION

Puciola gen. nov.

Hyphomycetes, dematiaceae. Hyphae hyalinae, septatae, ramosae. Conidiophora macronemata, brunnea, dichotoma, aliquando cum medio ramo, recta, erecta, acicularia. Cellulae conidiogenae breves, cylindricae, sub-inflatae, brunnae, gignentes acropleurogena conidia. Post maturitatem, conidia excidunt et conidiogenae cellulae longior et aciculariae fiunt sicut conidiophora sunt. Conidia iam non producuntur directe ex eo, sed ex novis lateralibus conidiogenis cellulis. Conidia holoblastica, singula, acropleurogena, unicellularia, ovoidea, pallide brunnea.

Species typica: *P. spinosa* spec. nov.

Puciola spinosa spec. nov. (Fig. 1 & 2)

Colonies lente crescentes, 2.1 cm diam. quattuordecim diebus, 26° C., fuscobrunnae vel nigrescentes, copiose sporulantes. Hyphae hyalinae, septatae, 1.0-1.5 µ in diam., tenuitunicatae. Conidiophora macronemata, brunnea, dichotoma, saepe cum medio ramo, recta, erecta, acicularia. Cellulae conidiogenae breves, cylindricae, sub-inflatae, brunnae, gignentes acropleurogena conidia. Post maturitatem conidia excidunt et conidiogenae cellulae longior et aciculariae fiunt sicut conidiophora sunt. Conidia iam non producuntur directe ex eis sed ex novis lateralibus conidiogenis cellulis. Conidia holoblastica, singula, unicellularia, ovoidea, pallide brunnea, attenuata ad basile septum, levia, 3.0-3.3x4.5-6.0 µ. Chlamydospora in substrata non formata.
Habitat in arenoso humo.

Colonies slow growing, 2.1 cm diam. in 14 days at 26° C. on 2% malt agar, dark brown to black with a whitish margin, flattened, partially immersed. Hyphae hyaline, septate, regular, thin walled, narrow, 1.0-1.5 µ diam. Conidiophores macronematous, up to 150 µ long, 2.2-3.0 µ diam., brown, septate, laterally beared by vegetative hyphae, emergent, dicotomously branched and often with a central elongation, straight, needle-shaped, bearing lateral conidiogenous cells. Conidiogenous cells cylindrical, short and slightly swollen in the middle, brown, bearing apically and laterally conidia. At maturity conidia fall and then the conidiogenous cell elongates becoming needle-shaped like conidiophores; conidia are no longer produced directly on it but on new lateral conidiogenous cells. Conidia holoblastic, numerous, borne singly and acropleurogenously, unicellular, light-brown, smooth, dry, caducous, oval with a little basal denticle and truncate at the attachment point, 3.0-3.3x4.5-6.0 µ. No chlamydospores or perfect state observed.

Habitat in sandy soil, Pisa, Italy. Culture in Istituto di Microbiologia Agraria, Pisa, Italy (n°555) and in CBS, Baarn.

DISCUSSION

The new genus *Puciola* is distinguished from other genera by the following features: (1) needle-shaped brown conidiophores dicotomously branched, often presenting a central elongation; (2) lateral cylindrical conidiogenous cells bearing acropleurogenously light brown conidia; (3) elongation of conidiogenous cells when conidia are fallen, becoming new conidiophores; (4) conidiogenous cells are never geniculate or with zig-zag form and do not present denticles but only small

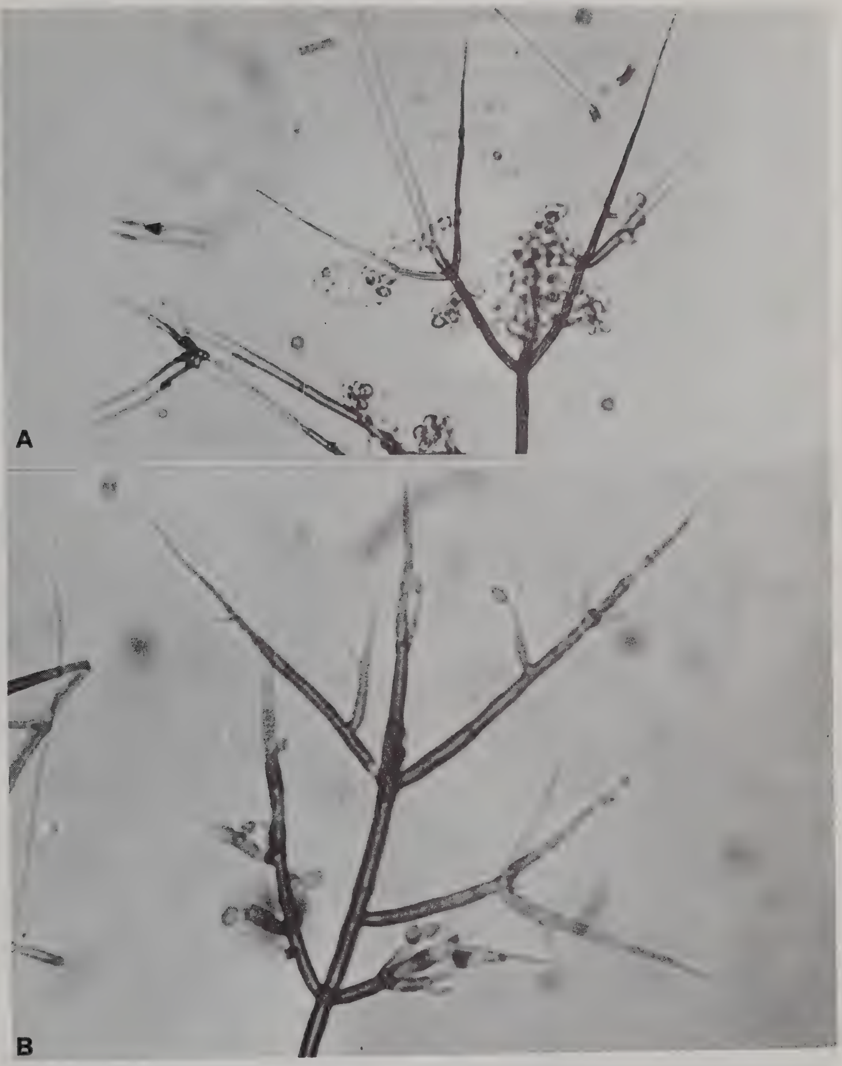


Fig. 1. *Puciola spinosa*. Conidiophores, conidiogenous cells and conidia in a young (A) and older culture (B); A x900, B x1400.

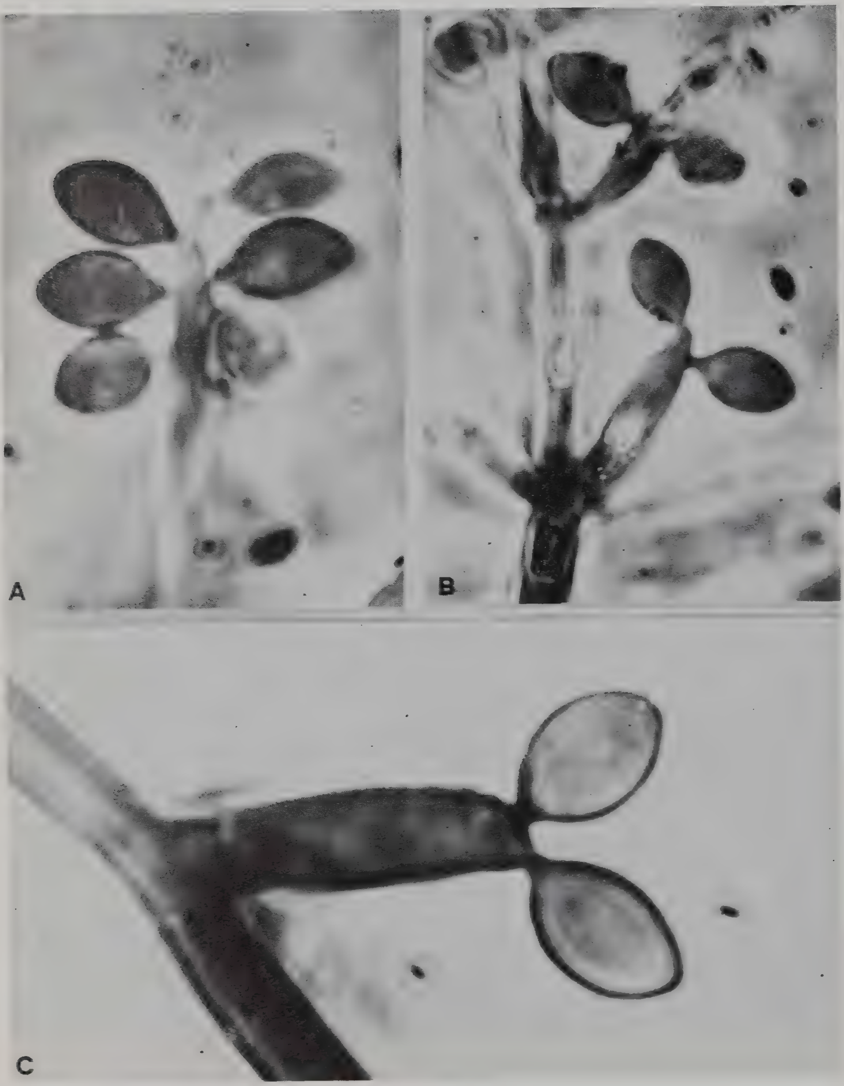


Fig. 2. *Puciola spinosa*. Conidiogenous cells and conidial development; A x3500, B x2500, C x4500.

scars; (5) the caducity of conidia.

Considering the above reported features this new genus is clearly different from the following similar genera: *Tritirachium* Limber, *Acrodontium* de Hoog, *Beauveria* Vuill (de Hoog, 1972), *Heimiodora* Nicot & Parguey (Nicot & Parguey, 1960; Benjamin, 1963), *Rhinocladiella* Nann. (Schol-Schwarz, 1968), *Geniculisporium* Chesters & Greenhalgh (Barron, 1968) and *Lomentospora* Hennebert & Desai (Hennebert & Desai, 1974).

The species here described recalls the conidial state of *Ascotricha erinacea* Zambett. The author who described that species referred its conidial state to *Myxotrichella* Sacc. (Zambettakis, 1955) a genus in which conidiogenesis is not well defined and, in any case, different from *Fusicola*. In a revision of the genus *Ascotricha* Hawksworth (1971) reports that the conidial state of *A. erinacea*, like that of *A. chartarum*, has to be referred to the genus *Dicyma* Boul.

We think that the genus *Fusicola* has to be considered different from the two genera above mentioned.

BIBLIOGRAPHY

Barron, G.L. (1968). The genera of Hyphomycetes from soil. *The Williams & Wilkins Co., Baltimore.*

Benjamin, R.K. (1963). Addenda to "The Merosporangiferous Mucorales" II. *Aliso 5, 273-288.*

De Hoog, G.S. (1972). The genera Beauveria, Isaria, Tritirachium and Acrodontium Gen. Nov. *Studies in Mycology, Baarn, 1, 41 p.*

Hawksworth, D.L. (1971). A revision of the genus Ascotricha Berk. *Commonwealth Mycological Institute, Kew, Mycological Papers No. 126.*

Hennebert, G.L. & Desai, B.G. (1974). Lomentospora prolificans, a new hyphomycete from greenhouse soil. *Mycotaxon, 1, 45-50.*

Nicot, J. & Parguey, A. (1960). Une moisissure nouvelle du sol en Extrême-orient: Heimiodora verticillata nov. gen., nov. sp. *Ann. Sci. Nat. Botan. Sér. 12, 1, 365-385.*

Schol-Schwarz, M.B. (1968). Rhinocladiella, its synonym Fonsecaea and its relation to Phialophora. *Ant. van Leeuwenhoek, 34, 119-152.*

Zambettakis, C. (1955). Un noveau Champignon papyricole. *Bull. Soc. Bot. Fr., 102, 219-225.*

BOOK REVIEWS *(continued from page 552)*

The author's wishes are to provide the amateur with what is hopefully to become a reliable tool (but still now to use with caution) for a rapid identification of the mushrooms, and to point out the need of more comparative and extended studies of these color reactions to serve field taxonomy. Certainly this interesting book will fulfill the author's wishes.

THE ENDOGONACEAE IN THE PACIFIC NORTHWEST, par J. W. GERDEMANN et James M. TRAPPE, 4 + 76 p., 28 figs. photogr. bl.-n. Mycologia Memoirs, No. 5, Juillet 1974. The Mycological Society of America, c/o The New York Botanical Garden, Bronx, NY 10458. $4.50 (USA), 5.50 (Foreign).

Après vingt années de recherche sur les Endogonacées, les auteurs nous présentent ce livre comme une synthèse des connaissances actuelles qu'ils ont acquises. Ils y distinguent sept genres. *Endogone* est le seul sexuellement différencié. *Gigaspora* et *Acaulospora*, deux nouveaux genres, produisent des "azygospores," cellules ressemlant aux zygopores, mais dont les suspenseurs, s'il en est, n'ont pas les caractères de gamétanges. S'ajoutent encore trois autres genres imparfaits, *Modicella* produisant des sporanges, *Glomus* des sclérocystes et *Glaziella* des chlamydospores. En revisant aussi bon nombre d'espèces de ces genres, observées ailleurs que dans le Nord-Ouest-Pacifique, les auteurs ont largement contribué à la monographie de cette famille des Mucorales. Onze espèces et vingt combinaisons sont nouvelles.

CBS COURSE OF MYCOLOGY, par W. GAMS, H. A. VAN DER AA, A. S. VAN DER PLAATS-NITERINK, R. A. SAMSON et J. A. STALPERS, 105 p., 73 fig., 16 × 24 cm. broché. Centraalbureau voor Schimmelcultures, Baarn, Pays-Bas, 1975. [In English.] Hfl. 15.- (NL), 20.- (Foreign).

Ce texte du cours introductif de mycologie systématique donné annuellement au C.B.S., Baarn, est constitué de 2 parties. La première est une résumé des principales méthodes d'isolement et de culture des champignons. La seconde, un exposé taxonomique des classes, ordres et familles des champignons, avec référence aux genres faisant l'objet de démonstration. Cette partie est introduite par un bref résumé des principes de nomenclature et se termine par une longue liste de références bibliographiques groupées par matière.

Notons deux points intéressants: la présentation de la Classe des Endomycètes, telle que la conçoit actuellement le Prof. J. A. von Arx, avec entre autres l'ordre des Endomycetales groupant les familles des Endomycetaceae *(Endomyces,*

(continued on page 564)

MYCOTAXON

Vol. III, No. 3, pp. 559-563 April-June 1976

NOTES ON HYPHOMYCETES. IX.
A NEW SPECIES OF *CURVULARIA*.

G. Morgan-Jones and G. W. Karr, Jr.

Department of Botany and Microbiology
Auburn University Agricultural Experiment Station
Auburn, Alabama 36830, U.S.A.

ABSTRACT

Curvularia gudauskasii Morgan-Jones and Karr, a new species, is described and illustrated. It is compared with *C. trifolii* (Kauffm.) Boedijn.

INTRODUCTION

A survey of microfungi occurring on varieties of corn grown for virus resistance testing at a substation of the Auburn University Agricultural Experiment Station System yielded a hitherto undescribed species of *Curvularia* Boedijn. Examinations of many collections of the morphologically similar *Curvularia trifolii* housed at the Commonwealth Mycological Institute, Kew, England, resulted in the discovery of another specimen of the organism found growing on leaves of *Cyanastrum johnstoni* in Tanzania. It can easily be distinguished from related species by conidium shape and dimensions, relative size of conidial cells and by hilum characteristics. It most closely resembles *C. trifolii*.

TAXONOMIC PART

Curvularia gudauskasii sp. nov (Figs. 1 and 3 E-K).

Coloniae effusae, grisea-brunneae, pilosae. Mycelium in substrato immersum, ex hyphis ramosis, septatis, pallide brunneis, levibus, 2.5-6µm crassis compositum. Conidiophora solitaria vel fasciculata, recta vel flexuosa, septata, brunnea, laevia, 62-98µm longa, 5-6µm crassa. Conidia acropleurogena, solitaria, elliptica, curvata, laevia vel verruculosa, 4-septata, brunnea, cellulis extimis pallidoribus, 27-29µm longa, 15-19µm crassa, hilo protudenti praedita.

In foliis vivis *Zea mays* L., Camp Hill, Tallapoosa Co., Alabama VII 1975, G. W. Karr, Jr., BPI, holotypus.

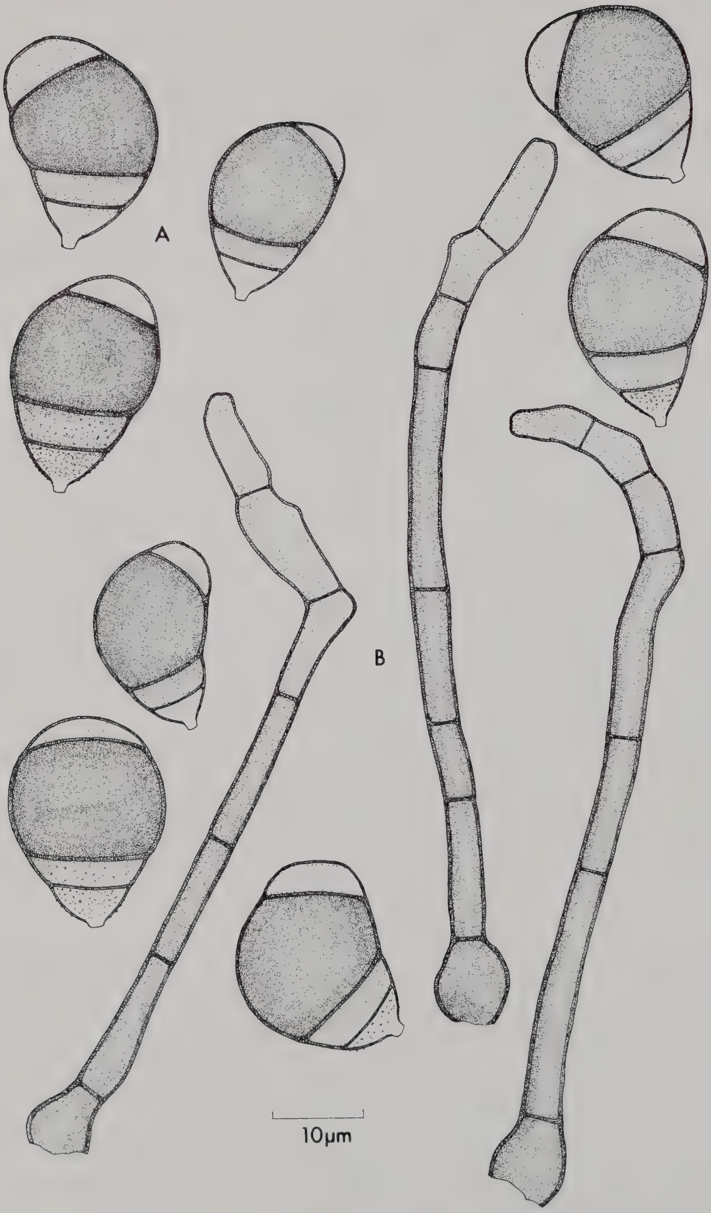


FIGURE 1. *Curvularia gudauskasii*. A, Conidia; B, conidiophores.

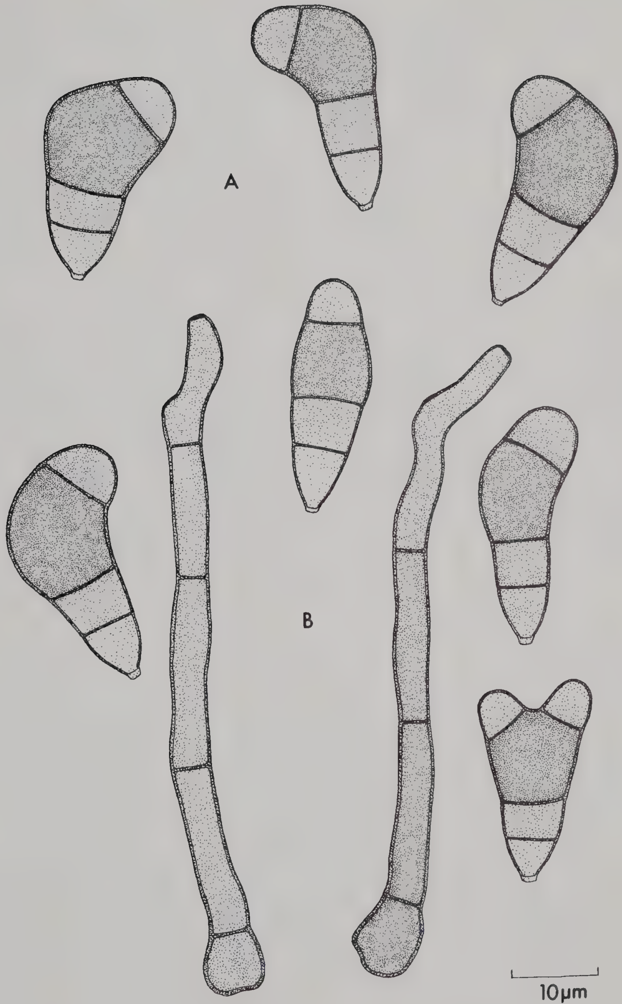


FIGURE 2. *Curvularia trifolii*. A, Conidia; B, B, conidiophores.

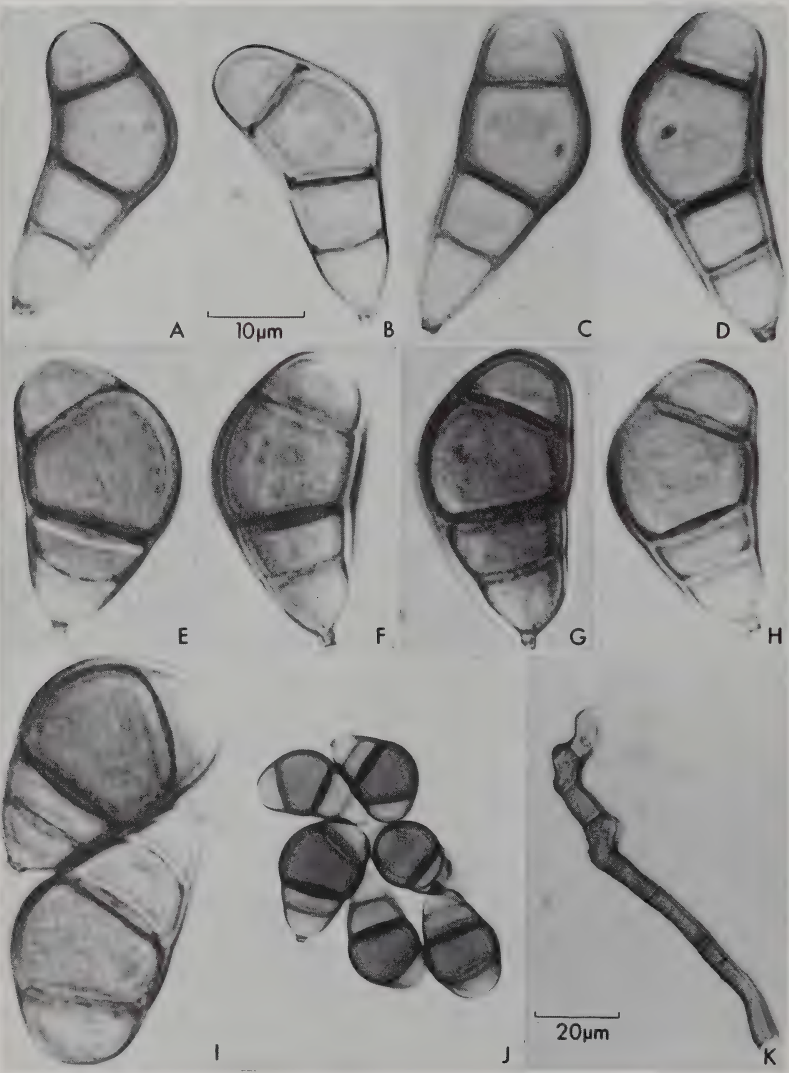

A
10µm
B
C
D
E
F
G
H
I
J
20µm
K

FIGURE 3. *Curvularia trifolii.* A-D, conidia; *Curvularia gudauskasii.* E-J, conidia; K, conidiophore.

The new taxon is named in honour of our colleague, plant pathologist Dr. Robert T. Gudauskas, whose work on corn diseases led to its discovery.

Colonies effuse, grayish-brown, hairy. Mycelium immersed in the substratum, composed of branched, septate, smooth, pale brown hyphae, 2.5-6μm wide. Conidiophores macronematous, mononematous, sometimes somewhat fasciculate, erect, simple, straight or flexuous, cylindrical, slightly nodose distally, septate, brown, paler towards,the apex, smooth, 62-98 X 5-6μm, up to 9μm wide at a bulbous base. Conidiogenous cells monotretic or polytretic, integrated, terminal and intercalary, sympodial, cylindrical. Conidia acropleurogenous, solitary, simple, broadly ellipsoidal to obovoid, curved, 4-septate, smooth-walled or with the walls of the lower two cells, especially the basal, minutely verruculose, brown, central cell darker and much larger than the end cells, apical cell frequently distinctly flattened at the top, basal hilum protuberant, up to 2μm long, 27-29 X 15-19μm.

On leaves of *Cyanastrum johnstoni* Baker and *Zea mays*; Africa and North America.

Specimens examined: (1) on *Zea mays*, Auburn University Agricultural Experiment Station, Piedmont Substation, Camp Hill, Tallapoosa County, Alabama, July 1975, G. W. Karr, Jr., BPI, AUA, type; (2) on *Cyanastrum johnstoni*, Mkenke, Kigoma, Tanzania, December 3, 1964, K. A. Pirozynski, IMI 107045, AUA.

DISCUSSION

A number of features serve to distinguish *C. gudauskasii* from *C. trifolii*. The conidia of the former are substantially broader and have, therefore, a significantly different shape, their central cell is much longer relative to the four end cells and the basal hilum is somewhat more prominent. We have examined the type collection of *C. trifolii* (Figs. 2 and 3 A-D); on *Trifolium repens*, Takoma Park, Montgomery County, Maryland, June-July 1919, C. H. Kauffman, MICH. The conidia of this species measure 23-30 X 8.5-14μm. Additional distinguishing features of *C. gudauskasii* are the flattened conidium apex and the verruculose nature of part of the conidium wall particularly that surrounding the basal cell.

ACKNOWLEDGEMENT

We thank Dr. M. B. Ellis, Commonwealth Mycological Institute, Kew, England, for allowing one of us (G.M-J) free access to the *Curvularia* collections housed in that institution.

BOOK REVIEWS *(continued from page 558)*

Dipodascus), Ascoideaceae *(Ascoidea)*, Saccharomycodaceae *(Saccharomycodes, Hanseniaspora)* et Saccharomycetaceae *(Saccharomyces, Hansenula)* (von Arx, 1976, Pilzkunde, 2d ed.). Aussi une intéressante comparaison des concepts de conidiogenèse de Kendrick (1971) et de von Arx (1974).

MYCOTAXON

Vol. III, No. 3, pp. 565-569 April-June 1976

ACAULOSPORA TRAPPEI SP. NOV.

ROBERT N. AMES

Department of Botany and Plant Pathology
Oregon State University, Corvallis, Oregon 97331

AND

ROBERT G. LINDERMAN

USDA/ARS, Ornamental Plants Research Laboratory,
Oregon State University, Corvallis, Oregon 97331

Acaulospora trappei is a new species of vesicular-arbuscular (VA) mycorrhizal fungus isolated from Easter lily fields in the Pacific Northwest. The epithet honors James M. Trappe for his contributions to mycorrhiza research.

The genus *Acaulospora,* as erected by Gerdemann and Trappe (1974), is distinguished from other Endogonaceae by the production of sessile azygospores budded below a terminal vesicle, which empties as the spore matures. The two species *A. elegans* Trappe & Gerd. and *A. laevis* Gerd. & Trappe have pigmented spores and produce lobed vesicles as part of the mycorrhizal association. *A. trappei,* as described herein, differs from those two species by having smaller, nonpigmented spores; by lacking, fine, emergent, branched hyphae below the spore attachment; and by forming round to irregular but not lobed vesicles within host cells of VA roots. Trappe (personal communication) has stated that still other *Acaulospora* spp. have been found and will soon be described.

Spores were collected by mixing 100 cc of soil in 1000 ml water, allowing one minute settling time, and decanting the solution through a series of screens. Contents of the lowest mesh screen (45-63 µm) were washed and suspended in water, and individual spores were collected with a pipetting device under a dissecting microscope (32X). Spores were mounted in distilled water for observation under a compound light microscope.

Mycorrhizae were examined by a modification of the technique of Phillips and Hayman (1970). Roots were cleared in 10% KOH at 55° C for 12 to 15 hours, washed twice in distilled water, acidified in dilute HCl (5.6 ml conc. HCl in 100 ml distilled water) for one hour, stained in 0.05% trypan blue in lactophenol at 55° C for 15 minutes, destained in clear lactophenol, and mounted in clear lactophenol for microscopic examination. This modification prevented air-bubble formation in the roots.

ACAULOSPORA TRAPPEI Ames & Linderman sp. nov. (see Figs. 1 and 2).

DESCRIPTION: Sporocarpia ignota. Sporae singulae in solo aut radicubus efformatae, sessiles, gestae lateraliter in cellula inramosa hyphali in vesiculo 50-82 X 42-72 µm prope terminatae. Sporae minute scabridae, 42-99 X 42-70 µm, globosae, ellipsoideae vel obovoideae, incolores; tunica ut vedetur singula, 1.2-2.3 µm crassa vel 3-4 µm crassa prope colligationem. Vesiculae intra mycorrhizas vesiculares-arbusculares inlobatae.

Sporocarps unknown. Spores formed singly in soil or occasionally within roots, sessile, borne laterally on a smooth, unbranched hyphal cell that terminates nearby in a subglobose to ellipsoid or obovoid vesicle 50-82 X 42-72 µm diam.; vesicles develop to full size before spore formation, with colorless oily contents that are transferred to the budding spore; the emptied vesicle often does not collapse. Spores are minutely roughened, 42-99 X 42-70 µm globose to ellipsoid or obovoid, colorless, containing rounded to polyhedral oil globules; wall apparently single, 1.2-2.3 µm thick, except sometimes thickened to 3-4 µm near attachment. Vesicles within VA mycorrhizae are not lobed.

DISTRIBUTION, HABITAT, AND SEASON: To date, A. *trappei* is known only from Easter lily fields along southern Oregon and northern California coastal areas. Spores can be sieved from soil throughout the year. Spores are formed abundantly in potted plant cultures after 4 months.

MYCORRHIZAL ASSOCIATIONS: A. *trappei* forms VA mycorrhizae with very finely branched arbuscules and unlobed vesicles. It is associated in field collections with roots

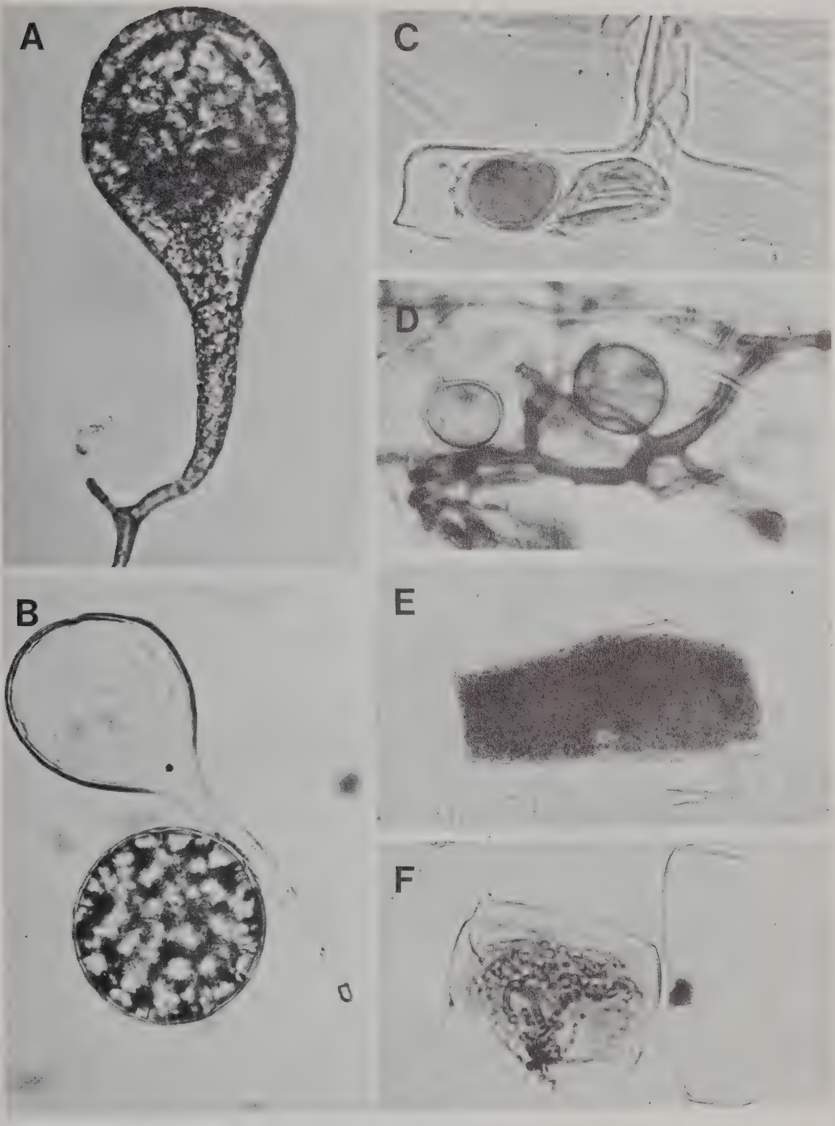


Fig. 1. (A-B) Fresh specimens mounted in water, X 500. (A) Immature vesicle before spore formation. (B) Mature spore with attached empty vesicle. (C-F) Squashed preparation of cleared and stained Easter lily roots in clear lactophenol, X 250. (C) Mature spore with attached vesicle in root-hair cell. (D) Vesicles. (E) Young arbuscle. (F) Partially digested arbuscule.

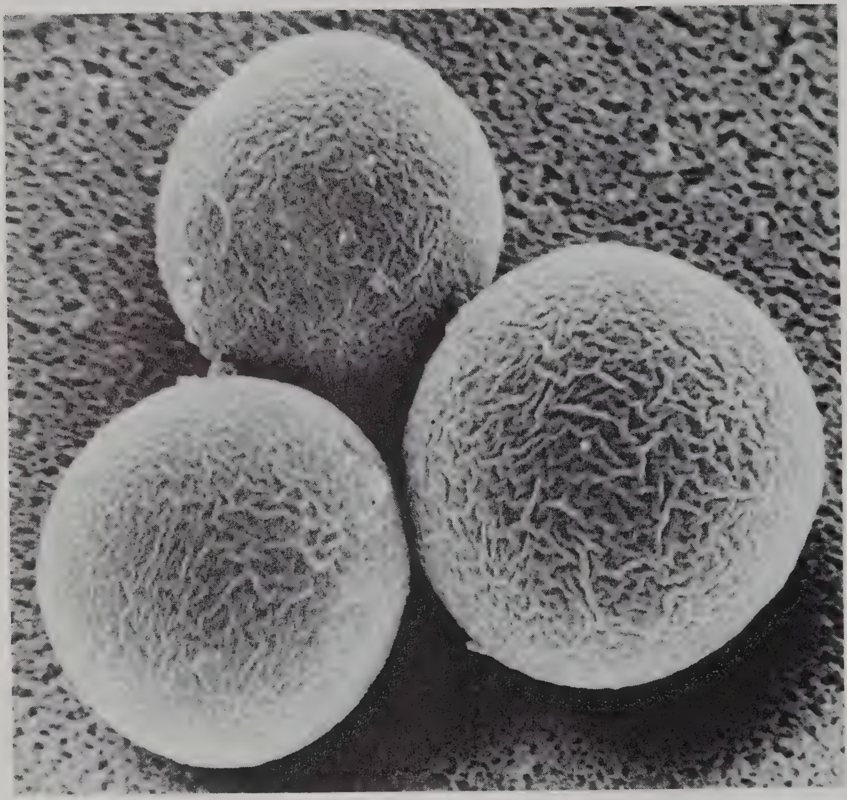


Fig. 2. Scan electron micrograph of A. *trappei* spores (X 700).

of Easter lily (*Lilium longiflorum* Thunb.) and it forms VA mycorrhizae in pot culture with Easter lily, red clover (*Trifolium pratense* L.), and onion (*Allium cepa* L.).

COLLECTIONS: Sieved soil, collected in April, 1975 from fields of *Lilium longiflorum,* was added to autoclaved sand in which seeds of *Trifolium pratense* were then planted. In September, 1975, newly formed spores were collected from the *T. pratense* pot cultures and used for the type and paratype specimens.

TYPE: OREGON, Curry Co., 4-8 km north of the Oregon-California boundary, at the Oregon Agricultural Experiment Field Station on U.S. Highway 101, near Harbor, Oregon; April, 1975, Ames #01 (OSC). PARATYPE: CALIFORNIA, Del Norte Co., 7.5 km south of the Oregon-California boundary on U.S. Highway 101, near Smith River, California; April, 1975, Ames #02 (OSC).

This study was supported in part by the Fred C. Gloeckner Foundation Inc.

The authors wish to thank Dr. James Trappe for the Latin description.

LITERATURE CITED

Gerdemann, J. W. and Trappe, J. M. 1974. The Endogonaceae in the Pacific Northwest. Mycologia Memoir 5:1-76.

Phillips, J. M. and Hayman, D. S. 1970. Improved procedures for clearing roots and staining parasitic and vesicular-arbuscular mycorrhizal fungi for rapid assessment of infection. Trans. Brit. Mycol. Soc. 55:158-161.

Oregon Agricultural Experiment Station Technical Paper Number 4180.

INDEX TO FUNGOUS AND LICHEN TAXA

This index includes genera, infrageneric taxa, species, and infraspecific taxa. New taxa are in CAPITALS, and the pages where they are published are in *italics;* new suprageneric taxa are in *ITALIC CAPITALS*. The list of epithets on pp. 244-260 is not indexed here.

Absidia 60; californica 61; cylindrospora 61, 71; spinosa 61, 341
Acaulospora 565; elegans 565; laevis 565; TRAPPEI 565, *566*, 568
ACICULOCONIDIUM 401, *407;* ACULEATUM 401, 404, *407*
Acremonium 65, 342; alabamensis 65, 71; curvulum 65, 70, 71; strictum 65, 69
Acrodontium 557
Acrothecium robustum 341
Actinomucor elegans 341; repens 341, 343
Aecidium nitens 139, 140
[Agrotelium hyptidis, *lapsus*, 154]
Albugo 30
Aleurodiscus 489
Allescheria boydii 64
Alternaria 341; alternata 342; tenuis 342
Ampullifera 132
Angiopoma 377-379; campanulatum 377-379
Angiopsora 157
Anthostoma 328; grandineum 326
Antrodia heteromorpha 489, 491, 493, 535-537
Arcyria 305; cinerea 299, 304, 305; denudata 299; insignis 304; leiocarpa 304; nutans 305
Argomyces 154; parilis 154
Argotelium 153, 154; hyptidis 154
Arnium 387, 388; absimile 389
Arthrinium 73; arundinis 342; phaeospermum 65, 70
Arthrobotrys 162, 163; dactyloides 162; entomopaga 162, 163
Ascobolus 69; epimyces 64
Ascodesmis 69, 73, 391, 392, 395; CANINUS 391, *392*-395; nigricans 64, 391; sphaerosporus 64
Ascotricha 557; chartarum 557; erinacea 557
Ascoidea 2
Aspergillus 72, 342, 420; alternatus 433; candidus 342; clavatus 342, 419; flavipes 65; flavus 342, 419; fumigatus 55, 65, 69, 71, 72, 342, 419; giganteus 419; glaucus 342; minutus 342; nidulans 419; niger 342, 414, 419, 465; ochraceus 342; quadrilineatus 342; sydowii 65; terreus 65, 342; ustus 342; wentii 342
Athelia coprophila 490, 495, 503
Auerswaldiella 325
Aureobasidium 397; pullulans 65, 343, 397
Auriscalpium 358; vulgare 358, 359

Bacidia marginalis 323
Badhamia affinis 300; gracilis 310; utricularis 310
Basidiobolus 46
Beauveria 557; bassiana 68, 69, 71, 342
Bispora 132
Boedijnopeziza 229
Boletus 261; sect Boletus 264; subsect Boleti 264; aereus 264; affinis 262, 272; amylosporus 273; BARROWSII 261, *262*, 264, 272; bicolor 272; calopus 272; chrysenteron 272; edulis 264, 272; erythropus 272; fragrans 272; luridus 262, 272; piperatus 272; porosporus 272; pulverulentus 272; rubripes 272; subglabripes 272; subtomentosus 272; subvelutipes 272; truncatus 272; vermiculosus 272
BOTRYANDROMYCES 193, *195*, 198, 202; HETEROCERATIS 193, *195*, 198, 200, 203; HETEROCERI 193, *196*-198, 200, 203
Botryosphaeria 325
Bovista ochrotricha 275
Brevilegnia diclina 60, 61
BURENIA 1, 9, *10*, 11, 30, 46, 47; CICUTA *11*, 12, 47; INUNDATA 11, *12*, 47
Byssochlamys 73; nivea 62, 70
Byssomerulius corium 488, 490, 494, 504, 505; sulphureus 490, 494, 504, 505

Caeoma callianthum 138, 139; divinum 138, 139; indicum 138, 139; interstitialis 139; nitens 139

Calonema luteolum 305, 306
Camarops grandinea 326
Candelabrella 163
Candida 65, 401, 407
Carpophoromyces 206
Catenulospora 133, 134; flacourtiae 133
Caulocarpa 170; montana 170, 171
Cephalosporiopsis 65, 73
Cephalosporium 342; crotocinigenum 416; curtipes 342
Ceratiomyxa fruticulosa 299
Cercospora 119, 120, 125; apii 120; ECUADORIANA 119, *120*, 122, 125; europea 119; latens f europaea 119, 120; NODOSA 119, 120, *122*, 124, 125; psoraleae 119, 120, 122; psoraleae-bituminosae 119, 120, 122, 125
Cerotelium 133, 134
Chaconia 137, 138; coaetanea 137
Chaetomium 60, 69; cochlioides 63; funicolum 63; seminudum 63; spirale 63; subspirale 63; torulosum 63
Chloridium chlamydosporis 65
Chloroscypha 165, 168, 171, 229, 230; sabinae 167, 169
Chroodiscus 175
Chrysocelis 137, 138; coaetaneum 138
Chrysomyxa 134, 136; simplex 134
Chrysosporium keratinophilum 64, 70, 71, 75; pruinosum 343
Ciboria acerina 223
Circinella 60, 61
Cladochytrium helocharidis 30; menyanthis 31
Cladosporium 342; cladosporioides 65, 70, 71, 342; herbarum 65, 70
Clavaria farinosa 240
Clavicorona 358; dryophila 358; pyxidata 358
Cleistothelebolus 388
Clitocybe illudens 363, 368, 369
Cochliobolus sativus 342
Coccospora aurantiaca 33
Coelopuccinia 134, 136; simplex 134; sinensis 136
Coelopucciniella 134, 136; idei 134, 136; simplex 134-136
Coleosporium 154, 155; campanulae 136, 137, 154; melampyri 137; rhinanthacearum 137
Colloderma 297, 298, 307, 316; oculatum 307; robustum 307, 308, 316
Colus schellenbergiae 373, 374
Comatricha 309, 315; elegans 308; longa 300; pulchella 300; subcaespitosa 309; tenerrima 309; typhoides 300
Coniochaeta 63, 69, 74; eremophila 489, 490, 494, 501, 502
Coniothyrium 68, 342; fuckelii 68, 70
Conoplea olivacea 189
Conotrema 234; harmandii 236; urceolatum 236
Cookeina 229
Coprotus 69, 73; niveus 64, 70
Cordana 73; pauciseptata 68
Corticium bombycinum 510; coprophilum 503; tuberculatum 521
Cortinarius 95; sect Dermocybe 95-97; cinnamomeus 97; clelandii 95-100; huronensis 97; incognitus 97; subcinnamomeus 95, 96; tubarius 95, 97
Costantinella terrestris 343
Craterium aureum 310; leucocephalum 300
Cribraria argillacea 303; violacea 304
Cunninghamella 60, 72; elegans 61; verticillata 342
Curvularia 559, 563; GUDAUSKASII *559*, 560, 562, 563; trifolii 559, 561, 563
Cyathicula 324
Cylindrocarpon 65; destructans 65
Cylindrosporium 120
Cyttaria 229, 230

Dacrymyces minor 490, 491, 496, 497, 499, 501
Dactylaria 68
Dermatea laricicola 168
Dermea 165, 168, 171; cerasi 189
Desmotelium 137, 138
Diatrype grandinea 326, 328
Dichotomyces 73; cejpii 62, 70
Dicoccum asperum 342
Dictydium cancellatum 299
Dicyma 557
Diderma crustaceum 315; effusum 300; hemisphaericum 300; niveum 315; spumarioides 315; testaceum 315
Didymium anellus 315; clavus 300; difforme 316; iridis 316; minus 316; nigripes 300; squamulosum 300
Didymosphaeria 328, 329; igniaria 65
Diheterospora chlamydosporia 64, 69, 71, 75
Diplodia 342

Diplogelasinospora 69, 73, 74; princeps 63
Discosia 342
Ditiola radicata 188
Doassansia alismatis 31; comari 29, 31; limosellae 31; martianoffiana 31; sagittariae 28, 33
Doratomyces microsporus 64
Dothidea asteroma 189, 190; vaccini 190
Drechslera 342, 377-379; CAMPANULATA *379*; verticillata 378

Echinostelium 297, 298, 304; minutum 304, 307
Ecteinomyces pusillimus 204, 205; trichopterophilus 205
Elateraecium 138, 139; divinum 138, 139; salicicola 138, 139
Eleutherascus 73, 395; lectardii 63, 70, 71
Endogone 31
Entyloma australe 32; calendulae 28; chrysosplenii 28; eryngii 29; fergussonii 30; ficariae 30; microsporus 31; ranunculi 31
Eoterfezia 387, 388; parasitica 387, 389, 390; PERLUCIDA 387, *388*, 389
Eriosphaeria raripila 414, 422
Eupenicillium 62, 69; levitum 62
Euphoriomyces 206
Eurotium 69; chevalieri 62; var intermedium 62, 70, 71; rubrum 62
Eustegia ilici 189; robertiani 189
Eusynaptomyces 194
Evernia 346; americana 347
EVERNIASTRUM *345*-347; AFRICANUM 345, *346*, 351; AMERICANUM *347*, 351; ARSENEI *347*, 350; CATAWBIENSE *347*, 350; CIRRHATUM 345-*347*, 349, 351; COLUMBIENSE *347*, 350; ECUADORIENSE *347*, 350; FISTULATUM *347*, 350; IMITATUM *348*, 351; LIMAEFORME *347*, 350; LIPIDIFERUM *348*, 351; MORELIENSE *348*, 351; NEOCIRRHATUM *348*, 350; NEPALENSE 346, *348*-350; NIGROCILIATUM *348*, 351; PACHYDERMUM *348*, 351; PERUVIANUM 345, *348*, 350, 351; PSEUDONEPALENSE *349*, 350; SOROCHEILUM 346, *349*, 350; SUBNEPALENSE 345, *349*-351; VEXANS 346, 347, *350*
Excipula punctiformis 189
Exidiopsis calcea 490, 492, 496-498; leucophaea 489, 490, 492, 497, 498

Fomes badius 531
Frommea 155; obtusa 155-157
Fuckelia grandinea 326
Fuckelina 414; albipes 423, 425; socia 414, 422, 423, 425
Fuligo cinerea 310; septica 300
Funalia gallica 491, 493, 544, 545
Fusarium 70, 73, 342; caudatum 342; concolor 416; equiseti 342, 416; moniliforme 65, 70, 342; nivale 342, 416; oxysporum 55, 66, 69, 71, 342; roseum 342; scirpi 416; solani 66, 71, 73, 342; tricinctum 342, 416
Fuscoboletinus 262; aeruginascens 272

Ganoderma lucidum 490, 492, 525, 526
Gelasinospora 69, 74; cerealis 63, 70
GELATINODISCACEAE 231
Gelatinodiscus 210-214, 219, 229-231; flavidus 209, 210, 213, 214, 216, 219, 220, 222, 224, 226
Geniculisporium 73, 557; serpens 55, 68, 69, 71
Geotrichum 406, 407
Gibberella zeae 416
Gliobotrys 414; alboviridis 342, 414, 423, 425
Gliocephalotrichum ohiense 66
Gliocladium deliquescens 66, 70; roseum 66, 69-71, 73, 342; virens 66
Gliomastix murorum var felina 66, 70
Gloiodon 358; strigosum 358, 360, 361
Gloniella 87; curtisii 86
Glonium 87; chlorinum 86; curtisii 82, 83, 86; cyrillae 86, 87; gigasporum 86; macrosporium 86
Gnomonia 63
Gongronella 60; butleri 61
Gonytrichum macrocladium 66
Guignardia 325
Gymnoconia 139, 140; hyptidis 154; interstitialis 139, 140; nitens 139; peckiana 139
Gymnosporangium 136, 140; biseptatum 135, 136; ellisii 135, 136; fuscum 140, 141, juniperi 140, 141; sabinae 140, 141
Gyroporus 262; castaneus 272

Hamigera 62, 73; avellanea 62
Hapalophragmiopsis 141, 142
Hapalophragmium 141; derridis 141;

millettiae 141, 142; mysorense 141; ornatum 141; ponderosum 141; pulchrum 142; setulosum 141
Haplographium 465; echinatum 464; musae 471
Heimiodora 557
Helminthosporium 342; anomalum 342; sativum 342
Helotiopsis 319, 323, 324; ANONYMA 319, 321-*323;* apicalis 319, 321-323; JENKINSII 319-*321*-323; marginalis 323
Hemitrichia 305; calyculata 306; karstenii 305, 306; serpula 299
Henningsomyces candidus 490, 493, 523, 524
Hericium 358; erinaceum 358
Heteroconium 130, 132; citharexyli 132
Hiratsukamyces 139
Hormiscium 342
Hormodendrum cladosporioides 342; pallidum 342
Humicola 109, 111, 113-117; alopallonella 111, 112, 117; brunnea 111, 112, 117; var africana 111, 112, 117; fuscoatra 111, 112, 117; grisea 111; var thermoidea 64, 71; parvispora 111, 112, 115, 117
Hyalopsora polypodii 30
[Hyalospora polypodii, *lapsus*, 30]
Hyalostachybotrys 414, 431, 433; bisbyi 430, 431; sacchari 430, 431
Hydnum chrysorhizon 521; erinaceum 358
Hymenochaete arida 491, 494, 525, 527; rubiginosa 491, 494, 528, 529
Hyphoderma 490, 496, 507, 508, 514; amoenum 490, 496, 506, 507
Hyphodontia quercina 490, 494, 508, 509
Hypochnicium 513; analogum 513; bombycinum 490, 495, 510-513; geogenium 513; PROSOPIDIS 487, 490, 496, 511, *512*, 513; punctulatum 513; sphaerosporum 513
Hypotrachyna 346
Hypoxylon 325; grandineum 325, 326, 328; serpens 167, 169
Hysterium 187; chlorinum 86, 87; curtisii 86, 87; cyrillae 86, 87; flexuosum 87; lineolatum 87; nova-caesariense 82, 84; pulicare 81
Hysteroglonium curtisii 86
Hysterographium 82; flexuosum 82; nova-caesariense 84; viticolum 87

Idriella lunata 342
Inonotus texanus 487, 488, 491, 492, 529, 530
Iodophanus 166; carneus 171

Kernkampella 142, 144, 146, 157; APPENDICULATA *142*, 143; BREVISPORA *142;* breyniae 142-144; breyniaepatensis 144, 157; COIMBATORICA 143, *144;* EMBLICAE *144*, 145; KIRGANELLAE *144;* PHYLLANTHI 145, *146*
Kuehnola 133, 134, 136; malvicola 134
Kunkelia 139, 140; nitens 139

Laboulbenia 194; heteroceratis 193-195, 206, 208; partita 202
Lactarius 336; sect Plinthogali 331, 334, 336; gerardii 336; LOUISII *331*, 332, 334, 336; xanthydrorheus 331, 336
Laeticorticium 489
Lambertella 166
Lamproderma acryrionema 309; echinulatum 309
Lasiobolidium 388
Leccinum 261; atrostipitatum 272; aurantiacum 272; brunneum 272; cinnamomeum 272; discolor 272; fallax 266, 272; incarnatum 272; insigne var brunneum 272; var insigne 272; f ochraceum 273; SUBALPINUM 261, *264*, 266, 273; vulpinum 272
Lentinellus 358; cochleatus 358
Leocarpus fragilis 312
Lepiota 381; cupressea 381, 383; marginata 381, 384, 385
Leptostroma spiraeae var rubi 189, 190
Licea 316; minima 303, 307; pedicellata 299
Lichenopsis 233, 236; sphaeroboloidea 233, 236
LOCULOHYPOXYLON *326*, 328, 329; GRANDINEUM *326*-328
Lomentospora 557
Lopharia crassa 491, 495, 545-547
Lophium 187; aggregatum 189, 190; sassafras 82, 83
Lycogala epidendrum 299

Lycoperdon 275, 282, 284, 286, 288, 290, 292, 293; americanum 290, 293, 294; ashantiense 291, 295; atropurpureum 284, 286, 293; atrum 276-278, 280, 282, 291-293, 295; bispinosum 291, 293, 295; calvescens 294; candidum 294; cruciatum 294; decipiens 293; delicatum 284, 286, 293; echinatum 290-294; floccosum 293; foetidum 290; juruense 276, 278, 280, 282, 295; mammiforme 293; marginatum 290, 294; mauryanum 284, 286, 293; MELANESICUM 277, 278, 284, *287*, 288, 292, 293, 295; molle 280, 290-293; perlatum 290; pulcherrimum 293; pyriforme 287, 288, 292, 293, 295; SETIFERUM 277, 278, 282, *284*, 292, 293, 295; umbrinoides 291, 293, 295
LYLEA *129*, 130, 132; CATENULATA 129, *130*, 131

Macbrideola cornea 309
Macrosporium 342
Magnusiella umbelliferarum 41
Malbranchea pulchella var sulfurea 65, 71
Marasmius siccus 491, 493, 547-549
Meionomyces 206
Melanopsamma pomiformis 414, 422, 423, 427, 429
Melanotaenium ari 28; endogenum 29, 30
Melittosporium 233, 236
Memnoniella 409, 413-415, 419, 421-423, 468, 469, 472; aterrima 464, 468; echinata 409-411, 414, 415, 417, 418, 420, 423, 464, 466-469, 472-474; levispora 469; subsimplex 410, 411, 423, 468, 470-473; zingiberis 469
Memnonium sphaerospermum 434
Merulius corium 504; sulphureus 504
Metarrhizium anisopliae 66, 69, 71, 420
Metatrichia vesparium 299
Microeurotium 388
Microsporon brachytomum 398
Microstoma 229
Misgomyces 193-195, 202; annae 193, 194, 204; clivinae 194; dyschirii 194, 197, 202; flexus 193, 194, 204; heteroceri 193, 196; perpendicularis 194; ptenidii 193, 194, 204
Mixia 8, 46; osmundae 46
Mollisiella anonyma 323; apicalis 322
Monadelphus subilludens 363, 368
Monosporium apiospermum 64
Morganella 280, 287; samoensis 287; velutina 275
Mortierella 55, 60, 70, 73, 342; alpina 61, 70; isabellina 61; marburgensis 61, 71; minutissima 61; mutabilis 61; nana 55, 60, 61, 71; parvispora 61; ramanniana 61; vinacea 61, 71; zonata 61, 70
Mucilago crustacea 316
Mucor 51, 59, 60; circinelloides 342; corticolus 61; fragilis 62, 70; glomerula 342; griseo-cyanus 62; hiemalis 55, 60, 62; lausannensis 342; mucedo 62; racemosus 62, 342
Mycoacia AUSTRO-OCCIDENTALE 487, 490, 494, *513*
Mycogone 64, 70, 73
Mycothyridium 329
Myrothecium 209, 228; roridum 416; verrucaria 416
Mytilidion 81, 82; nova-caesariense 84; sassafras 83
Mytilinidion 81, 82
Myxotrichiella 557

Nectria 73; episphaeria 63, 70
Neurospora crassa 420
Nigredo fallens 149, 150
Nodulisporium 55, 68, 69, 73
Nothoravenelia 146; commiphorae 146

Ocellularia 175, 233, 234, 236; CARNEODISCA *173*, 174, 179; chonestoma 174; dilatata 177; exanthismocarpa 176; GROENHARTII *173*, 174, 179; LOPEZII 173, *174*, 179; nylanderiana 174; MAGNIFICA *234*, 236; MAURETIANA *175*, 179
Odontia pruni 490, 494, 514, 515
Oidiodendron flavum 65
Oidium chartarum 433
Omphalotus 363, 367-369, 371; illudens 368, 371; olearius 363, 367-371; OLIVASCENS *363*-365, 367-369, 371; subilludens 368
Oospora chartarum 433
Orbicula 388
Ostreichnion 81-83, 88; americanum 81, 83; CURTISII 81, 83, 84, *86*-88; europaeum 81; NOVA-CAESARIENSE 81, 83, *84;* SASSAFRAS 81-*83*, 84
Ostreion 81; americanum 81-83

Ostreola 82; consociata 82

Pachyella 105, 107, 166, 170, 171; adnata 105, 107; babingtonii 107; clypeata 107; megalosperma 107; punctispora 105, 107; violaceonigra 105, 107
Paecilomyces 60, 420; bacillisporus 66; carneus 66; elegans 66; fumoso-roseus 66, 70; marquandii 66, 69, 71, 73; varioti 66
Panus fulvidus 489, 491, 493, 549, 550
Papulospora 342
Paradiacheopsis cribrata 309
Parmelia subg Everniiformes 345; sect Everniiformes 345; americana 347; arsenei 347; camtschadalis 347; cirrhata 345, 347; columbiensis 347; ecuadoriensis 347; fistulata 347; imitata 348; limaeformis 348; lipidifera 348; moreliensis 348; neocirrhata 348; nepalensis 348; nigrociliata 348; pachyderma 348; pseudonepalensis 349; sorocheila 349; var catawbiensis 347
Passariniella 329
Patellaria livida 168; rubi 168
Penicillium 55, 60, 67, 69, 72, 342, 465; adametzii 342; brevicompactum 66, 70; chrysogenum 342; citrinum 66, 342; claviforme 420; clavigerum 420; commune 66, 70, 342; corymbiferum 66, 420; cyclopodium 66; daleae 66; decumbens 342; digitatum 342; declauxii 342; echinatum 342, 464, 465, 468; expansum 342; frequentans 66, 67; funiculosum 67, 342; godlewskii 342; granulatum 67; humicola 342; intricatum 342; janthinellum 67, 342; lilacinum 342; nigricans 67, 69, 342; notatum 67; piceum 342; purpurogenum 67, 342; raistrickii 67; restrictum 342; roqueforti 67; roseum 342; rubrum 67; rugulosum 67; simplicissimum 343; steckii 67; stoloniferum 67, 342; thomii 67, 69-71; velutinum 67; viridicatum 342; waksmanii 67
Peniophora 499; albobadia 488, 490, 495, 514-516; amoena 506; nuda 489, 490, 495, 516, 517; sambuci 510; tamaricicola 488, 490, 495, 499, 517, 518
Perichaena 305; chrysosperma 300; depressa 305, 306; liceoides 306; microspora 305; quadrata 305, 306
Periconia igniaria 65; papyrogena 464
Peronospora alsineriarum 33
Pestalotia 73; lespedezae 68; mangifolia 68
Petriella 69, 73; guttulata 63
Peyronellaea 342
Pezicula 165, 168, 171; acericola 169, 170
Peziza 105, 166, 170, 171; apicalis 322; flammea 189, [languinea, *lapsus*, 191]; repanda 170; resinae 189; sanguinea 189, 191
Pezizella anonyma 319, 323
Pezoloma iodocyanescens 166
Phacidium patella 189; rugosum β 189, 190; shizoxylon 189
Phaeotrema 175; FOLIICOLA *175*, 179; STICTICUM *176*, 179
Phakopsora 134; vitis 157
Phanerochaete allantospora 489, 490, 495, 518-520; arizonica 489, 490, 495, 519, 520; chrysorhizon 490, 494, 521, 522; tuberculata 489, 490, 495, 521, 522
Phaulomyces 206
Phellinus badius 487, 488, 491, 492, 530, 531; ferruginosus 489, 491, 492, 531-533; gilvus 491, 492, 532, 533
Phialocephala 126; dimorphospora 420; gabalongii 126, 127; humicola 126, 127
Phialomyces 420
Phialophora 67, 70; richardsiae 420
Phlebia ochraceofulva 490, 495, 523, 524
Phoma 68, 70, 342; betae 342; prunicola 68
Phomopsis 69, 70
Phragmidium 155, 156; obtusum 156, 157; potentillae 155-157; tormentillae 155, 156
Phragmotrichum acerinum 189
Physarella oblonga 300
Physarina echinospora 300
Physarum bogoriense 310-313; cinereum 313; citrinum 313; compressum 300; globuliferum 300; melleum 314; mutabile 314; nicaraguense 300; oblatum 300; penetrale 314; pusillum 314; stellatum 300; sulphurinum 300; tenerum 300; vernum

300; virescens 315
Physcia 102; DUPLICORTICATA *102*-104; millegrana 104; tribacia 104
Physoderma gibbosum 23
Physopella 134, 157; vitis 157
Phytophthora 343
Platygloea mycophila 490, 492, 499, 500; peniophorae 490, 492, 496, 499-501
Platygrapha magnifica 233, 234
Platysticta 233, 234, 236; magnifica 233, 234; simulans 233, 234, 236
Podospora 387, 388; communis 389
Polychidium 355; STIPITATUM *355*-357
Polyporus arcularius 491, 493, 536, 537; gilvus 532
Poria ambigua 539; apacheriensis 491, 493, 538, 540; BABOQUIVARIENSIS 487, 491, 493, *538*-540; ferruginosa 531; latemarginata 491, 493, 539, 541, 542; medulla-panis 491, 493, 541, 542; subincarnata 491, 493, 542, 543; tarda 489, 491, 493, 543-545
Protomyces 1-4, 6-12, 14, 19, 21, 24, 27-32, 44, 46, 47; andinus 15, 16, 18, 19, 27; ari 28; belledis 34; bidentis 18, 27; bizzozerianus 28; burenianus 15, 16, 18, 28; calendulae 28; calthae 28; cari 23; carpogenus 28; centaurea 24; centelli 28; chrysosplenii 28; cocae 28; comari 29; concomitans 29; conglomeratus 29; corticola 29; crepidicola 24; crepidis 24, 25; crepidis-paludosae 24; crisii-oleracei 24; cyrenaicus 29; endogenus 29; eryngii 29; erythronii 29; fallax 29; var albellinensis 30; fergussonii 30; ficariae 30; filicinus 30; fuscus 30; giganteus 16, 18; gaillardiae 30; galii 30; graminicola 30; GRANDISPORUS 14, *18*, 19; gravidus 14, 19, 27; helminthae 25, 27; heleocharidis 30; helosciadii 10, 12; hispanicus 30; inouyei 6, 8, 14, 15, 19, 21, 47; inundatus 3, 4, 6, 8, 10, 12; ixeridis-oldhami 21, 27; kemneri 30; kreuthensis 24; kriegerianus 24; lactucae 21, 27; lactucae-debilis 15, 21, 27; leniaris 31; limnanthemii 31; limosellae 31; macrosporus 1, 3, 4, 6-8, 10, 12, 14, 21, 23, 28; macularis 31; martianoffianus 31; martindalei 31; matricariae 16, 23, 25; melanodes 31; menyanthis 31; microsporus 31; muscorum 31; najadis 32; pachydermus 4, 14, 15, 23-25, 27; paridis 32; persicifilus 32; physalidis 32; picridis 24; pithiophilus 32; polysporus 32; punctiformis 32; purpureo-tinges 32; radicicola 32; reticulatus 32; rhizobius 33; sagittariae 33; sonchi 16, 25, 35; stellariae 33; theae 33; tuberum-solani 33; vagabundus 33; violaceus 33; wodziczkoi 18, 28; xylogenus 33
Protomycopsis 2, 4, 6-9, 21, 33, 34, 38, 39, 46, 47; ajmeriensis 39; arnoldii 34, 38; belledis 4, 34, 35; chrysanthemi 38; crepidis 24; crotolariae 39; hyoseridis 34, 35; leontodontis 34, 35; leucanthemi 34, 38, 41; patelli 39; pharenris 39; phaseoli 39; pulicariae 39; thirumalacharii 39, 40
Prototheca filamenta 89-93, 398, 399
Pseudevernia 346
Pseudocolus 373; javanicus 373, 374
Pseudoeurotium 73; punctatum 63; zonatum 63, 70
Pseudohelotium apicalis 322
Psiloglonium cyrillae 86
Puccinia 154; discolor 148, 149; gibertii 154; hyptidis 154; instititia 148; juniperi 140; NEOHYPTIDIS *154;* nerviphila 150; parilis 154; potentillae 155, 156; pruni-spinosae 148; f discolor 148, 149; prunorum 148; trifolii 151, 152
Pucciniola nerviphila 150
PUCIOLA *553*, 554, 557; SPINOSA 553, *554*-556
Pullularia pullulans 343
Pyrenochaeta 69, 70, 343; decipiens 69; terrestre 343
Pyrenophora 379; semeniperda 378, 379
Pythium 343

Radulum quercinum 508
Ravenelia 136, 142, 146; appendiculata 142; brevispora 142; breyniae 144; breyniae-patensis 144, 157; coimbatorica 144; epiphylla 146, 147; glandulosa 146; kirganellae 144, 157; ornata 146, 147; phyllanthi 146; pygmaea 145, 146
Reticularia intermedia 303
Rhabdocline 168, 229, 230; pseudo-

tsugae 167, 168; weirii 168
Rhinocladiella 557; mansonii 68, 70
Rhizoctonia solani 69, 343
Rhizopus 60; arrhizus 62, 343; elegans 343; nigricans 343; stolonifer 343

Saccobolus 69, 73; globuliferellus 64
Sarcinomyces 397, 398; albus 397; crustaceus 397; inkin 89, 93, 398
SARCINOSPORON 89, *92*, 397, 398; INKIN 89, *93*, 398
Sarcotrochila balsameae 167
Sartorya 69; fumigata 62, 70
Sclerospora graminicola 30
Scopulariopsis candida 64
Sebacina calcea 496
Semidelitschia 325; agasmatica 325
Sepedonium chrysospermum 343
Septonema 130, 132
Setchellia punctiformis 32
SIEMASZKOA 193, *202*, 205, 206; ANNAE 193, *204*-206; FLEXA 193, *204*-206; PTENIDII 193, *204*-206
Solenia candida 523
Sordaria 69, 74, 387; fimicola 63
Sorosporium paridis 32
Spermophthora 44
Sphaeria 187; abducens 188; [rank?] minor 188; alligata 189; ambiens 187; applanata 189; arbuticola 189, 190; brevirostris 189; bullata 189; calvescens 189, 190; caulium 189, 190; cerasorum α 189; β 189, 190; cirrhosa 189; clypeata 189; complanata 191; β minor 189; corni [rank?] suecicae 189; corticis 189; craterium 189, 191; deplanata 189, 190; diminuens 189, 191; disciformis 187; doliolum 189; dothidea 189; eutypa 191; var [undecipherable] 189, 191; excipuliformis 187; favacea 189; fibrosa 189; filicina 187; fimbriata 188; galii 189; inquinans 189; lanciformis 187; lata 188; lejoplaca 188; β 189, 191; lirella 189; lonicerae 189, 190; macrostoma 189; mammaeformis 189; mammillana [rank?] minor 189; melogramma 189; mutila β 189; mutilaria 188; nucula ... platystoma 188; ocellata β 188; omalogramma 189, 190; oppilata 189; pertusa 189; pomiformis 422; prorumpens β 189; prunastri 188; pupula β philadelphi 189; rigida 189; salicina 189, 191; semitecta 189, 190; spiculosa 189; stellulata 189, 191; stricta var [unnamed] 190; strobilina 189; suffusa 188; tessella 188; thelebola 189; tristis 189; tubaeformis 187; tubeformis 187; uberiformis 189; uda 189; vibratilis 188-190; xanthostroma 189
Sphaeronema hemisphaerica 187; subulatum 189
Sphaeropsis 343
Sphaerosporium lignatile 33
Spicaria simplicissima 343
Spongospora scabies 33
Sporocybe albipes 422, 423, 425, 427; lobulata 434
[Sporomiella leporina, *lapsus*, 64]
Sporormiella 73; leporina 64, 70, 71
Sporotrichum pruinosum 343; thermophile 64, 71
Stachybotrys 409, 413-415, 419-423, 431, 432, 435, 461, 465, 468, 469, 472, 473; ALBIPES 410, 411, 424, *425*-427, 429, 430; alternans 415, 434, 439; asperula 434; atra 413-415, 417, 419, 420, 433, 435, 438, 439, 442, 443, 472; var brevicaulis 438; var cylindrospora 440; var genuina 438; var lobulata 438; var microspora 439, 448, 449, 451, 474; atrogrisea 434; aurantia 418, 430-432; bambusicola 433; bisbyi 410, 411, 418, 423, 428-430, 432, 433; chartarum 409-411, 415-420, 424, 433, 435-438, 442, 443, 449, 451, 472, 474; crassa 464; cylindrospora 67, 343, 410, 411, 424, 440-442; dakotensis 434; dichroa 410, 411, 424, 430, 442-445; echinata 464; elasticae 434; gracilis 434; kampalensis 410, 411, 424, 446-448, 474; lobulata 434, 438; MICROSPORA 410, 411, 424, *448*, 450, 451; nephrospora 410, 411, 424, 452-455, 474; nilagirica 464; oenanthes 410, 411, 424, 455-457; palmijunci 433; papyrogena 464; parvispora 410, 411, 424, 458-460; pulchra 434; reniformis 410, 453-455; sacchari 410, 430, 432, 433; scabra 434; sinuatospora 410, 453-455; socia 414, 422, 423, 425, 427; subsimplex 342, 413, 414, 468, 471, 472; theobromae 410, 411, 423, 424, 460, 462-464,

474; verrucosa 434; voglinii 434
Staphylotrichum 73; coccosporum 64, 70
Stemonitis axifera 310; fusca 310; pallida 300; smithii 300; splendens 300; trechispora 300; virginiensis 310
Stemphylium 343
Stereum albobadium 514
Sterigmatobotrys papyrogena 464
Stictis 234, 236, 238; parallela 187; populea 234
Stilbospora chartarum 414, 433
Stilbothamnium nudipes 420
Strattonia 63, 69, 73, 74; minor 63
Strossmayeria 166
Suillus 261, 270; sect Suillus 268, 270; albidipes 268, 272, 273; americanus 271, 273; brevipes 270, 273; brunnescens 273; flavogranulatus 273; flavoluteus 272; glandulosipes 273; granulatus 268, 272, 273; hirtellus 272; KAIBABENSIS 261, *266*, 268, 273; lakei 273; luteus 273; OCCIDENTALIS 261, *268*, 273; pseudobrevipes 273; sibericus 271, 273; subaureus 262, 270, 273; tomentosus 273; umbonatus 273; WASATCHICUS 261, 268, *270*, 272, 273
Syncephalastrum 51; racemosum 51, 54, 343; VERRUCULOSUM *51*, 52, 54
Synchytrium phaseoli 39
Synsporium 414; biguttatum 434

Taeniolella 132
Talaromyces 55, 60, 69; flavus var flavus 62; helicus 70; var helicus 62; luteus 55, 60, 62; trachyspermus 55, 60, 62; ucrainicus 62, 70; udagawae 62; wortmannii 62
Taphridium 2, 4, 6-8, 10, 11, 40, 43, 46, 47; algeriense 40, 41; cicutae 4, 6, 11; crepidis 43; inundatus 12; umbelliferarum 40, 41, 44
Taphrina 3, 7, 43, 44, 46, 47; oreoselini 41; rhaetica 43; umbelliferarum 41
Thelebolus 2
Thelotrema 236; colobolicum 177; CONFERENDUM *176*, 179; decorticans 178; EITENII *176*, 179; EMINENS *177*, 179; INDICUM *177*, 179; insigne 178; ISIDIATUM *178*, 179; leprocarpum 177; MERIDENSE *179*; tuberculiferum 177, 178
Thermoascus 73; aurantiacus 63, 70, 71
Thyridium 329
Tomentella coerulea 491, 494, 546, 548
Torula 342; thermophila 68, 70, 71
Trametes heteromorpha 535; hispida 544
Tranzschelia discolor 147, 149; pruni-spinosae 148; var discolor 148, 149; var pruni-spinosae 148, 149; f discolor 149
Tremella sabinae 140; simplex 490, 492, 496, 500, 501
Triactella 142
Triangularia 69, 73, 74; backusii 63
Trichia decipiens 300; favoginea 300; varia 306; verrucosa 300
Trichobasis 157, 158
Trichocladium asperum 342; canadense 64
Trichoderma 55, 60, 69, 70, 72, 337-341, 343; album 343; aureoviride 67, 337-341; glaucum 338, 343; hamatum 55, 67, 69, 71, 338-340; harzianum 67, 69, 337-341; koningii 55, 67, 69, 70, 337-341; lignorum 338, 343; longibrachiatum 67, 70, 341; piluliferum 341; polysporum 55, 68, 69, 338-341, 343; pseudokoningii 68, 338-341; saturnisporum 341, 420; viride 338-340, 343, 416
Trichophaea 69; abundans 64
Trichophyton terrestre 64, 75; tonsurans 89
Trichosporon 89, 90, 398, 401, 406, 407; aculeatum 401, 406, 407; inkin 89-91, 93, 398, 399
Trichosporum effusum subsp binucleatum 434
Trichothecium roseum 434, 416
Tritirachium 557
Trochila craterium 191
Trypethelium 174
Tubercinia paridis 32
Tubifera ferruginosa 303; microsperma 303
Tylopilus 261; alboater 262, 273; ferrugineus 273; porphyrosporus 273
Tympanis frangulae 187

Uredo 155; campanulae 137; fabae 157, 158; fallens 149, 150; hyptidis 153, 154; melampyri 138; obtu-

sa 155-157; potentillae 155; rhinanthacearum 138, 154; tremellosa var campanulae 137, 154, 155; trifolii 151, 152; vitis 157
Uromyces 150; affinis 151; anthyllidis 152; fallens 149, 150, 152; flectens 150, 151; iresines 151; minor 152; nerviphilus 150-152; striatus 152; trifolii 150-152; var fallens 149; trifolii-repentis 150-152
Urophlyctis hemisphaerica 33
Usnea 349
Ustilago haesendonckii 33

Valsaria 323, 329; crenata 323; insitiva 329
Vararia tropica 491, 494, 534, 535
Verticillium 68; albo-atrum 420; cephalosporium 68; nigrescens 420; psalliotae 68; terrestre 343
Vibrissea 166
Volkartia 2, 4, 6-8, 10, 43, 46, 47; rhaetica 4, 43, 44; umbelliferarum 41
Volutella ciliata 68, 70, 73

Xanthoparmelia camtschadalis 347; chlorochroa 580; wyomingca 580
Xeromyces 388
Xylohypha 132

Zygorhynchus 60; moelleri 62

REVIEWERS

The Co-Editors express their appreciation to the following individuals who have reviewed one or more of the papers in this volume prior to their submission.

C. J. ALEXOPOULOS
G. L. BARRON
L. R. BATRA
C. R. BENJAMIN
R. K. BENJAMIN
T. E. BROOKS
J. VAN BRUMMELEN
H. H. BURDSALL, JR.
S. E. CARPENTER
W. B. COOKE
J. L. CRANE
E. E. DAVIS
R. DONOVICK
D. M. DRING
M. L. FARR
J. W. GERDEMANN
R. D. GOOS
R. T. HANLIN
D. L. HAWKSWORTH
C. L. HESSELTINE
J. W. KIMBROUGH
D. S. KING
D. T. KOWALSKI
M. J. LARSEN
P. L. LENTZ
J. P. LINDSEY
T. H. NASH
J. T. PALMER
R. H. PETERSEN
D. H. PFISTER
K. A. PIROZYNSKI
A. F. RAINBOW
A. RAMBELLI
C. T. ROGERSON
G. SAYRE
M. A. SHERWOOD
R. A. SHOEMAKER
E. G. SIMMONS
A. H. SMITH
E. A. D. SNELL
W. H. SNELL
H. D. THIERS
J. W. THOMSON
J. M. TRAPPE
J. WALKER
F. A. WECKER
M. WIRTH

ERRATA TO VOLUME TWO

Page 219, Fig. 1 is *Xanthoparmelia chlorochroa* and Fig. 2 is *X. wyomingca.*

ERRATA TO VOLUME THREE

Page 30, line 15:	*for:*	*Hyalospora*
	read:	*Hyalopsora*
Page 64, line 3:	*for:*	**Sporomiella*
	read:	**Sporormiella*
Page 154, line 33:	*for:*	*Agrotelium*
	read:	*Argotelium*
Page 191, line 28:	*for:*	*languinea*
	read:	*sanguinea*
Page 216, line 2:	*for:*	CE
	read:	C-E
Page 282, line 33	*for:*	Grave
	read:	Grove
Page 286, line 4:	*for:*	10-16
	read:	7-9
Page 287, line 6:	*for:*	10 μ, paries 2,6 μ)
	read:	20 μ, paries 7 μ)
Page 295, line 26:	*for:*	2,6 μ)
	read:	7 μ)
Page 296, line 7:	*for:*	höheren
	read:	Höheren
Page 298, line 37:	*for:*	Alexopoulos (1968)
	read:	Alexopoulos and Blackwell (1968)
Page 317, line 2:	*for:*	Alexopoulos, C. J. 1968.
	read:	Alexopoulos, C. J. and M. Blackwell. 1968.
Page 319, line 25:	*for:*	(Obrien
	read:	(O'Brien

CO-EDITORS OF MYCOTAXON

G. L. HENNEBERT
FRENCH LANGUAGE EDITOR
& BOOK REVIEW EDITOR

Huttelaan 36
B-3030 Heverlee, Belgium

RICHARD P. KORF
ENGLISH LANGUAGE EDITOR
& MANAGING EDITOR

P.O. Box 264
Ithaca, NY 14850, USA

MYCOTAXON is a quarterly journal devoted to all phases of mycological and lichenological taxonomy and nomenclature. It seeks to publish all papers within 4 months of acceptance, using photo-offset lithography. All articles are reviewed by specialists prior to acceptance. Publication is open to all persons, and papers may be in French or in English.

SUBSCRIPTION INFORMATION

Each issue of MYCOTAXON may vary in number of pages. Each volume, beginning with volume 3, consists of at least 512 pages, and may consist of as few as 2 or as many as 8 quarterly issues depending upon the amount of copy received from authors. Subscriptions are on a per volume basis, *not* on an annual basis. If only one bill during each year is a requirement, please pay for two volumes, which will cover at least one year's issues. Personal subscriptions are available at a substantially reduced subscription rate for individuals who agree not to deposit their copies in another library than their private one within three years after publication. Subscription prices for each volume, beginning with volume 3, are:

	U.S. & CANADA	OTHER FOREIGN
Regular (multi-user)	$30.00	$32.00
Personal (individuals only)	$12.00	$14.00

(Vols. 1 & 2 are available at half the above rates per volume.)

MYCOTAXON may also be obtained on a journal-exchange basis. This may be arranged with journals, institutions, or individuals who have difficulty in obtaining foreign currencies. For details and exchange subscription forms write to a Co-Editor.

EDITORIAL SERVICES AND INFORMATION FOR PROSPECTIVE AUTHORS

Authors prepare their own camera-ready copy after having received comments from pre-submission reviewers. Detailed Instructions to Authors appeared in MYCOTAXON 1(1): 3-12. 1974. A copy of these instructions will be sent upon request to one of the Co-Editors.

We are able to provide prospective authors with two aids to publication. Both are sold at no profit, and are shipped postpaid from MYCOTAXON, Ltd., P.O. Box 264, Ithaca, NY 14850 USA:

SPECIAL MANUSCRIPT PAPER is available in packages of 50 sheets, and is ruled in blue, non-photoreproducing ink for each of the two sizes of typeface called for in the instructions to authors (elite and pica). It is a convenience to typists, but certainly not an essential, since the appropriate sized rectangles can be prepared on any paper using a non-photoreproducing blue pencil. Each package of 50 sheets is available at $1.25, *postpaid*.

BIOPLATE is a special sheet of transfer letters for the use of authors in the preparation of plates and graphs for publication. It is manufactured specifically for us, and is available in both black and white. Each sheet is approximately 30 × 39 cm, and has a wide assortment of numbers, letters, Greek letters, symbols, and arrows in various sizes. Our cost is $3.00 per sheet, and we will mail these to prospective authors *postpaid* (black will be sent unless white is specified).